

(12)

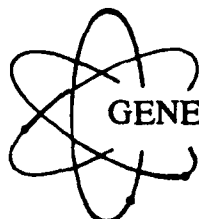


US Army Corps of Engineers
Hydrologic Engineering Center

AD-A273 611



2



GENERALIZED COMPUTER PROGRAM

DAMCAL

DTIC
ELECTE
DEC 13 1993
S A

Damage Reach Stage-Damage Calculation

User's Manual

February 1979

93-30134



Approved for Public Release. Distribution Unlimited.

CPD-35

93 12 10038

DAMCAL

Damage Reach Stage-Damage Calculation

User's Manual

February 1979

Accession For		
NTIS	CRA&I	<input checked="" type="checkbox"/>
DTIC	TAB	<input type="checkbox"/>
Unannounced		<input type="checkbox"/>
Justification		
By		
Distribution /		
Availability Codes		
Dist	Avail and/or Special	
A-1		

DTIC QUALITY INSPECTED 3

Hydrologic Engineering Center
US Army Corps of Engineers
609 Second Street
Davis, CA 95616

(916) 756-1104

CPD-35

DAMAGE REACH STAGE-DAMAGE CALCULATION
(DAMCAL)

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	4- 1
OVERVIEW	4- 2
Input Limitations	4- 4
Hardware and Software Requirements	4- 4
SPECIFIC CAPABILITIES	4- 5
Damage Reaches	4- 6
Reference Flood	4- 6
Composite Damage Functions	4- 8
COMPUTATIONAL PROCEDURES	4-11
Aggregation of Damage Functions	4-11
NONSTRUCTURAL MEASURES	4-17
Uniform Flood Proofing of a Land Use to a Specified Stage	4-17
Flood Proofing to a Specified Protection Level	4-19
Response to Flood Warning Dissemination	4-21
Permanent Evacuation of the Flood Plain	4-23
Flood Plain Regulation	4-24
SINGLE EVENT COMPUTATION	4-28
Future Program Additions	4-29
INPUT PREPARATION	4-29
General Description	4-29
Program Data Hierarchy	4-29

TABLE OF CONTENTS (continued)

	<u>Page</u>
DATA CARD DESCRIPTION	4-30
Title Cards, T1, T2, T3	4-30
First Job Card, J1	4-30
Second Job Card, J2	4-31
Third Job Card, J3	4-31
Fourth Job Card, J4	4-31
Fifth Job Card, J5	4-31
Sixth Job Card, J6	4-31
Seventh Job Card, J7	4-31
Eighth Job Card, J8	4-31
Format Card, FT	4-31
Single Flood Event Title Card, ST	4-32
Composite Land Use Cards, LU, LT, DF, DS, DC, DO, DD	4-32
Damage Reach Cards, DR, DT, SE, LC	4-33
Ending Card, END	4-33
OUTPUT DISPLAY	4-33
Input Listing	4-34
Title	4-34
Job Cards	4-34
Format Data	4-34
Composite Land Use Damage Data	4-35
Damage Reach Index Location Summary	4-35
Single Events for Damage Reaches	4-36
Trace Information as Specified on the J8 Card	4-37
Aggregated Damage Output	4-37
SAMPLE PROBLEMS	4-37
REFERENCES	4-39
 EXHIBITS	
4-1 DAMCAL - Stage Damage Calculation	
4-2 Economic Effect of Single Flood Events on the 1990 Land Use Plan	
4-3 Flood Proofing New Development to a Specified Height above Zero Stage	
4-4 Flood Proofing New Development to the Existing 100-year Flood Level	
4-5 Regulating New Development such that the Zero Stage is Placed above the Existing 100-year Flood Plain	
4-6 Utilizing Flood Plain Regulation, Flood Proofing and Evacuation	
4-7 Input Description	

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
1	Damage Reach Delineations	4- 7
2	Reference Flood Concepts	4- 9
3	Development of a Composite Elevation-Damage Function for a Grid Cell	4-12
4	Translation of the Grid Cell Elevation-Damage Function to the Damage Reach Index Location . .	4-14
5	Damage Aggregation Process	4-15
6	Flood Proofing Selected Land Use Categories . . .	4-18
7	Flood Proofing Required for a Target Protection Level.	4-20
8	Grid Cell Damage Functions (Target Protection Level Specified)	4-22
9	Multiple Flood Elevations in Conjunction with Permanent Evacuation of the Flood Plain	4-24
10	Grid Cell Elevation-Damage Function Adjustment for Flood Plain Regulation	4-26

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
1	DAMCAL Analysis Capabilities	4- 3
2	Composite Stage-Damage Function for a Particular Residential Land Use Category . . .	4-10
3	Aggregated Damage-Functions for Damage Reach 32 at the Index Location	4-16
4	Comparison of Expected Annual Damage	4-27
5	Aggregated Elevation-Damage Values for a Particular Land Use Category	4-28
6	Program Data Hierarchy.	4-30

DAMAGE REACH STAGE-DAMAGE CALCULATION (DAMCAL)

Introduction

The DAMCAL (damage reach stage-damage calculation) computer program documented in this section is part of a family of computer programs, which includes the HYDPAR program discussed previously in Section 3, that make up the Spatial Data Management and Comprehensive Analysis System. These programs are part of an ongoing effort to provide a systematic and comprehensive technique for managing and analyzing spatial data for use in water resources management investigations.

The DAMCAL program, like HYDPAR, is designed to access data and information stored in a grid cell data bank similar to the one developed for the Trail Creek Watershed (U.S. Army Corps of Engineers, 1975). The particular methods used in storing and accessing spatial data (or information) which are utilized by this computer program are described in a guide manual available from the Hydrologic Engineering Center (U.S. Army Corps of Engineers 1978).

An overview of the programs requirements and capabilities are presented herein. In addition, the input necessary for program execution and related output are described in detail for the benefit of the user. Sample input and output has also been included to demonstrate the capabilities of the system and as a data set for testing the computer program.

The DAMCAL program is maintained and distributed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, 609 Second St., Davis, California, 95616. This agency should be contacted for any questions regarding its use or availability.

Overview

Water resource planners are charged in the plan formulation process to evaluate a broad range of alternative flood damage reduction measures that will provide flood damage relief for existing and future land use conditions. The plan formulation process requires developing alternative means for accomplishing performance targets and selecting from those alternatives the ones which are the most attractive. This necessitates the systematic assessment of the economic value of the proposed alternatives. In such cases it is desirable that alternatives be compared quickly, with the comparisons based on an adopted and consistent methodology.

Spatial analysis methods provide the mechanism for expedient and consistent economic evaluation of alternative flood damage reduction measures. The methods used include the evaluation of geographic information which has been digitized and stored in computer files in digital form. Each geographic data variable is encoded separately and a registered grid cell representation of each data variable is stored in a sequential grid cell record as a part of the DATA BANK.

The geographic data variables that are used to perform the damage analysis are: 1) topographic elevation, 2) reference flood elevation, 3) damage reach delineation, 4) existing land use classification, and 5) alternative future land use patterns. Each alternative analysis utilizing the DAMCAL program results in the creation of an aggregated elevation-damage function for each land use category at each damage reach index location. The functions may be analyzed conventionally by damage-frequency integration methods or used as input into more complex system formulation models, such as the ATODTA-HEC-1 linkage (described in Section 5 of this document).

The DAMCAL computer program accesses the geographic information stored in a grid cell DATA BANK for the evaluation of 1) the existing land use condition and 2) any number of future land use conditions or specific land development proposals. A powerful analytical capability in the DAMCAL program is the

ability to evaluate nonstructural alternatives such as flood plain management policies, flood proofing alternatives (raising structures, levees, the addition of flood proofing materials to structures, etc.), permanent evacuation of structures in the flood plain, temporary structural protection and content removal in response to flood warnings, and any combination of the preceding. The alternatives may be evaluated in terms of providing a target protection level (such as protection from the 100-year flood event) or in providing uniform land use category protection (for example, flood proofing industrial structures to a height four feet above existing ground elevation). Table 4-1 summarizes the functional capabilities of the DAMCAL program.

TABLE 4-1
DAMCAL ANALYSIS CAPABILITIES

Alternatives	Land Use Pattern		
	Existing	Alternative Future	Alternative Future
			New Development Only
Do Nothing (Without Condition)	X	X	
Structural Flood Control Measures	X	X	
Uniform Flood Proofing of a Specified Land Use Category	X	X	X
Uniform Flood Protection of a Damage Reach	X	X	X
Temporary Evacuation	X	X	
*Permanent Evacuation	X	X	X
*Flood Plain Regulation	X	X	X

X Indicates analytical capability

* Evaluations may be made for structures in the flood plain and for structures which have their zero damage elevation in the flood plain.

Input Limitations. As in the case of the HYDPAR program, the input requirements for DAMCAL are designed so that individual user data input requirements can be accommodated as much as possible. Thus a dynamic array similar to one used in the HYDPAR program has been written into DAMCAL to allow a certain degree of flexibility in the selected number of data variables, land use categories, damage reaches and elevations for the stage-damage computations. In general, the number of land use categories and damage reaches will be the limiting variables in the dynamic array.

The limits on data input for the DAMCAL program are given below:

<u>Input</u>	<u>Variable</u>
Number of Damage Reaches	NODR
Number of Land Use Categories	NOLUC
Number of Elevations for the Elevation-Damage Relationship	IELV
Number of Single Flood Events	ITYPE
Number of Data Variables in the Grid Cell Data Bank	NDV

$$x = (IELV + ITYPE) * NOLUC * NODR \quad (4-1)$$

x cannot exceed 122,000

$$z = 37(NODR) + 78(NOLUC) + IELV(NODR + 1) + 4(NOLUC)(NODR) + NDV \quad (4-2)$$

z cannot exceed 23,000

Hardware and Software Requirements. The DAMCAL program was developed using a CDC 7600 computer at the Lawrence Berkeley Laboratory, University of California, Berkeley, California. In general it is compatible with other major computer systems. (Difficulties in installation should be reported to the Hydrologic Engineering Center).

Program Language:	FORTRAN IV (ANSI standard)
Memory Requirement (limit):	470,000 words (octal) of core (word size - 60 bits)
Special Library Functions:	None
Printer Positions:	132
Tape Assignments:	Tape 1: Grid cell data bank Tape 2: Single event damages Tape 5: Standard card input Tape 6: Standard line printer Tape 20: File that may be saved or passed to ATODTA (ATODTA included in Section 5 of this document)
Storage Devices (permanent):	3 magnetic tapes or disk file units

Specific Capabilities

Methods of computing the flood damage potential of a stream system require the development of elevation-damage functions at selected damage reach index locations throughout the system. The elevation-damage functions are then integrated with hydrologic flow-frequency and flow-elevation data to compute the value of expected annual damage (U.S. Army Corps of Engineers 1977). Damage reaches are defined to capture economic and hydrologic variation that occur in the system. Usually elevation (or stage)-damage relationships are developed for each individual structure, the associated value of the contents, and an optional damage category called "other" within the damage reach of interest. The damage functions are then aggregated to an index location by adjusting elevation related data to account for the slope of the water surface profile in a particular reach.

The technique developed for automatically generating elevation-damage functions in the DAMCAL computer program adapts the traditional method to grid cell data bank concepts. The methodology, in general, consists of constructing a unique elevation-damage relationship for each grid cell within the flood plain based on topographic data (ground elevations) and land use, and

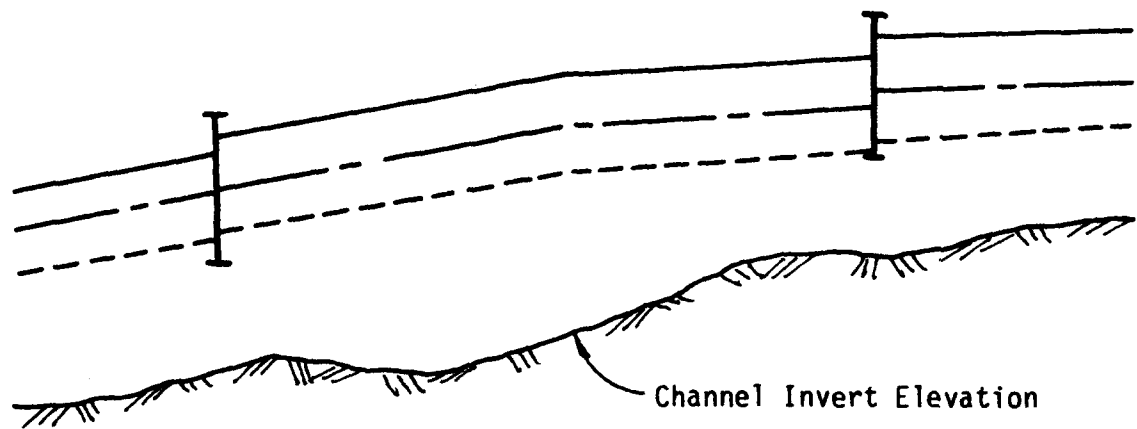
then aggregating the damage potential of all grid cells assigned to a particular damage reach to an appropriate index location.

Damage Reaches. Damage reach boundaries are selected based on a procedure of determining reaches with consistent parallel water surface profiles for a range of discharges while maintaining the economic detail desired for analysis. The lateral boundaries extend a reasonable distance from the stream to the edge of the flooded area of the largest flood event deemed necessary for economic-damage evaluations, plus an additional horizontal increment to insure coverage of proposed and future conditions (Figure 4-1 illustrates typical damage reach delineations). The damage reaches are encoded into the grid cell data bank and each cell within a particular reach is assigned a damage reach identification value or code. The damage reach identification is then used to insure that the grid cells are aggregated with respect to the appropriate damage reach index location.

Reference Flood. Since a flood profile yields different water surface elevations throughout a damage reach, a representative (or reference) flood event is required to properly adjust the topographic (or first floor) elevation of each grid cell for aggregation purposes within a particular reach (with respect to the index location). Each cell is assigned a reference flood water surface elevation which is used with the reference flood elevation at the index location to adjust the individual damage functions (for proper aggregation of damages at the index location).

The reference flood should be an event within the range which is critical for flood damage computation, a mid-range flood event (a 25 to 50 year event) is often more appropriate than a rare flood with a 500-year exceedance interval. Historic flood events are often used as reference floods. If the flow profiles for different discharge rates are consistently parallel throughout the potential damage range, the selection of the reference flood is not as critical. The reference flood elevations should be determined

WATER SURFACE PROFILES



DAMAGE REACH DELINEATION

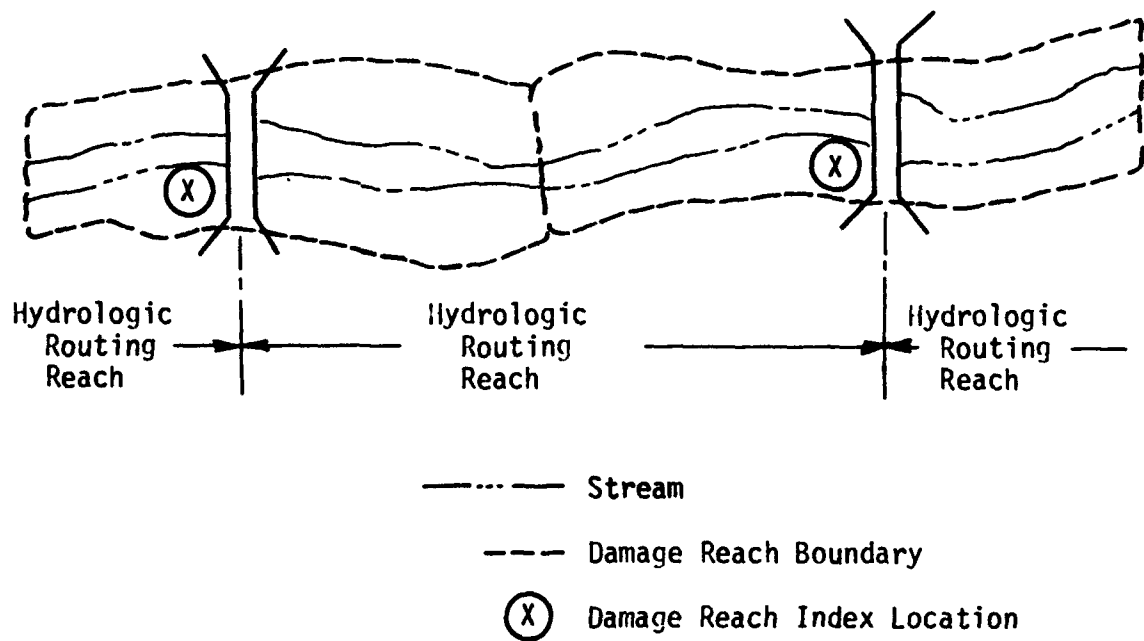


FIGURE 4-1

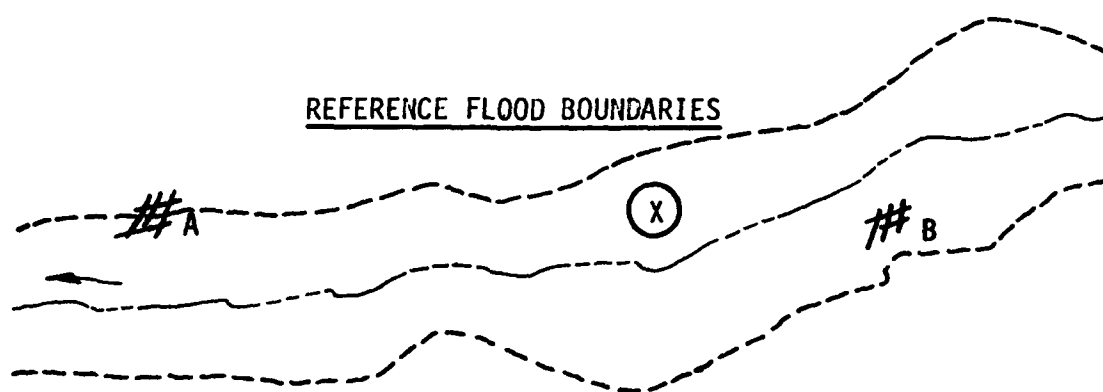
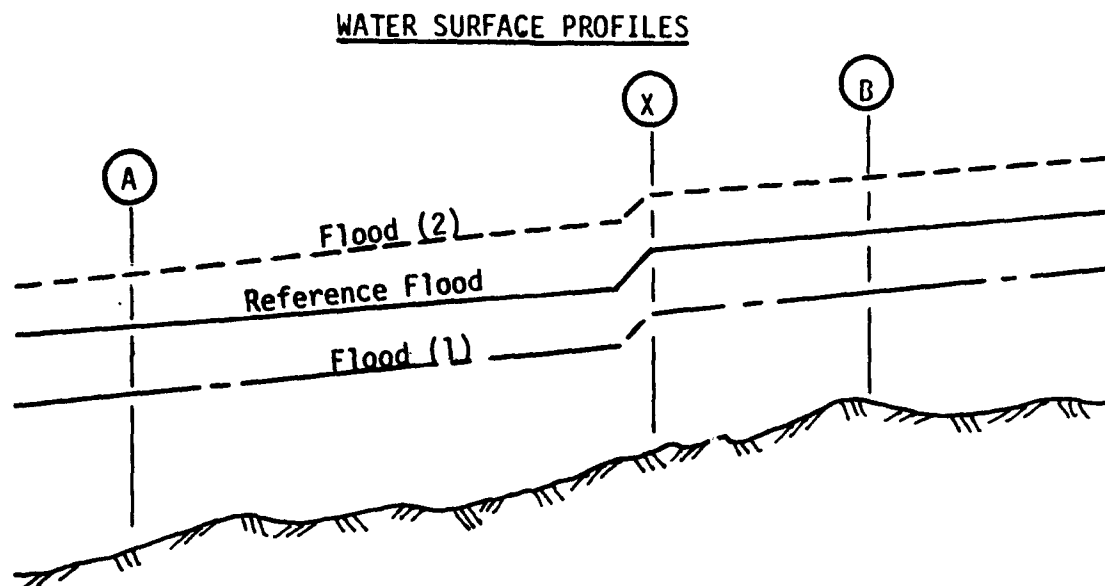
DAMAGE REACH DELINEATIONS

from good quality high water marks or detailed water surface profile analyses. Figure 4-2 illustrates the adjustments performed using the reference flood water surface elevations.

Composite Damage Functions. The general objective of the analytical methods developed is to provide a consistent and expedient methodology of evaluating a range of structural and nonstructural alternatives for existing and selected alternative future land use patterns. The concept of using generalized composite stage-damage relationships for the land use category assigned to each grid cell was selected as the mechanism to perform the analysis rather than the conventional individual structure approach alluded to previously. The use of the generalized functions provides the capability to evaluate expeditiously alternative land use patterns that are consistent with the existing (base) condition land use pattern.

A composite damage function is defined as a stage-damage function for a specified area within each adopted land use category that has significant damage potential. The functions may be developed for each land use category by averaging the structural and related content values obtained from sampling a range of structure values and types within each specified category (by utilizing field surveys, review of tax records, interviews conducted with regional and local agencies, etc.). The composite damage function can include direct and indirect damages associated with each particular land use category. Table 4-2 illustrates an example of a composite stage-damage function within a particular land use category. The functions can be developed for other land use categories such as pasture, developed open space, etc., although the corresponding damages are small when compared to those occurring in the structurally developed areas.

DAMCAL can be used to develop the composite stage-damage function for a specific land use category based on the following types of information:



Reference Flood
Water Surface Elevations

Index location = 614.5

A = 610.0

B = 617.0

Structure Locations

(X) Index Location

--- Boundary of Reference Flood

— Stream

Damage Functions at A must be adjusted by adding 4.5 feet (614.5-610.0) before aggregating to the index location.

Damage Functions at B must be adjusted by subtracting 2.5 feet (614.5-617.0) before aggregating to the index location.

FIGURE 4-2
REFERENCE FLOOD CONCEPTS

TABLE 4-2
COMPOSITE STAGE-DAMAGE FUNCTION FOR
A PARTICULAR RESIDENTIAL LAND USE CATEGORY

Depth of Water	Percent Damage (Structure)	Percent Damage (Contents)	Amount of Damage Per Grid Cell (In Thousand Dollars)
-2.00	1.00	0.00	.24
-1.00	1.00	0.00	.24
0.00	10.00	2.00	2.48
1.00	13.00	33.00	5.02
2.00	20.00	54.00	7.91
3.00	27.00	66.00	10.28
4.00	30.00	73.00	11.40
5.00	33.00	77.00	12.34
6.00	35.00	80.00	12.99
7.00	36.00	81.00	13.29
8.00	40.00	81.00	14.23
9.00	41.00	81.00	14.47
10.00	41.00	81.00	14.47
11.00	45.00	81.00	15.42
12.00	45.00	81.00	15.42

Density of the land use (units per grid cell) = 1.50

Base value of the structure \$20,000.00

Base value of the contents = \$5,000.00

Vacancy factor (percent developed) = 75%

Indirect damages are 5.00 percent of the total grid cell dollar damage

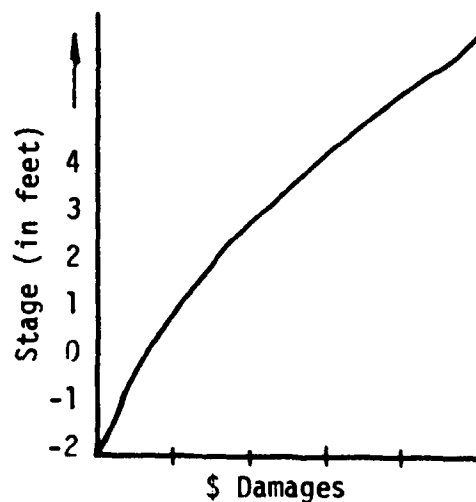
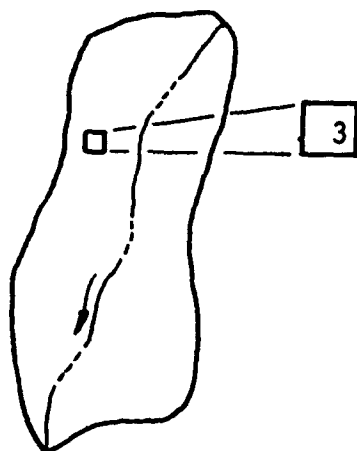
- . Stage versus % damage to structure
- . Stage versus % damage to contents
- . Value of structure
- . Value of contents (option, % of structure value)
- . Indirect damage (% of total grid cell dollar damage)
- . Development density (number of structures per grid cell)
- . Vacancy allowance (amount of land classified in the particular category that is developed)

Computational Procedures

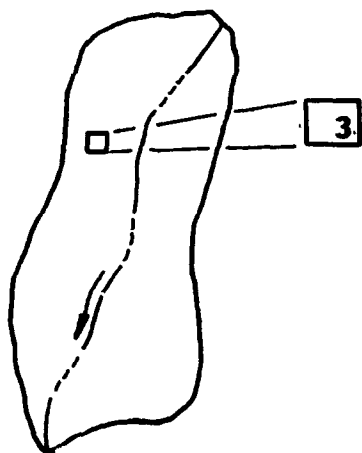
Aggregation of Damage Functions. The creation of an aggregated elevation-damage function for each damage reach index location can be done once the spatial data variables (topographic elevation, reference flood elevation, damage reach identification and land use patterns) are in the DATA BANK and composite damage functions have been developed for each land use category.

The DAMCAL computer program accesses the DATA BANK and for each grid cell in the flood plain manipulates the appropriate data in the following manner:

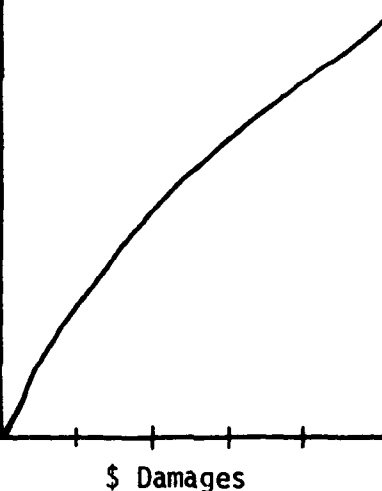
- (1) The land use of the cell is determined and the corresponding composite stage-damage function is placed at the grid cell (Figure 4-3a).
- (2) The stage axis of the function is converted to elevation by equating the zero stage to either ground elevation or first floor elevation. The conversion of stage to elevation completes the placement of the composite damage function at the grid cell (Figure 4-3b).
- (3) The next step in the aggregation process is to transfer the grid cell elevation-damage function to the index location. The data bank is accessed to determine in which damage reach the cell is located and then the function is translated to the appropriate index location by adjusting the elevation axis of the damage function. The adjustment



- (a) Land use 3 (low density residential) with the composite stage-damage function shown.



Stage	Elev	Elev* w/1st Floor
4	674	676
3	673	675
2	672	674
1	671	673
0	670	672
-1	669	671
-2	668	670



- (b) The stage is converted to elevation based on the reference datum of the composite damage function.

* For land use 3 the first floor elevation is 2 feet above the ground elevation.

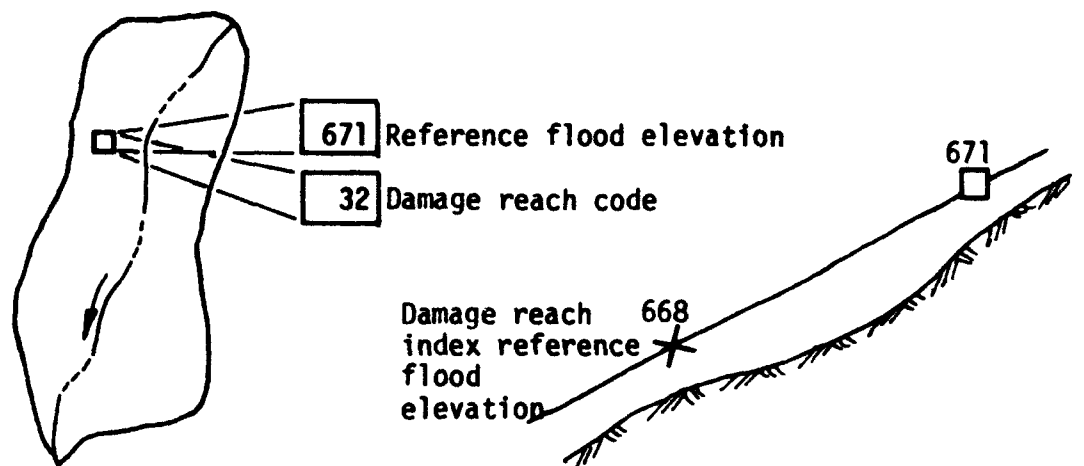
FIGURE 4-3
DEVELOPMENT OF A COMPOSITE ELEVATION-DAMAGE FUNCTION FOR A GRID CELL

is based on the difference between the reference flood water surface elevations at the grid cell and the index location. Figure 4-4 shows a grid cell upstream of the index location with a difference in reference flood elevations of 3 feet. In this case the elevations of the grid cell elevation-damage function (elevation-damage function in which the zero stage coincides with the first floor elevation) are reduced by 3 feet to complete the translation process.

- (4) The resulting grid cell aggregated elevation-damage function (Figure 4-4) is then combined with the elevation-damage functions of other grid cells having the same land use category (land use 3) and which were previously aggregated to the index location (for damage reach 32). (Combined damage functions are separated based on land use categories so that damage calculations may be subdivided according to a particular interest). Figure 4-5 shows the aggregated damage potential of the sample grid cell being combined with the existing (aggregated) damage potential at the index location for land use 3.

If, for example, there are five land use categories in a particular damage reach and the damages for each grid cell in the reach have been aggregated to the index location, then a summary of the computed aggregated damage functions for the various land uses would appear as shown in Table 4-3. The total aggregated damage function (a summation of the individual functions) is also included.

The aggregation procedure described is the same for all DAMCAL runs, whether evaluating existing or alternative future conditions. The difference in the evaluation of nonstructural measures (described in the following paragraphs) is in the modification of the composite damage function or in the modification of the elevation axis of the elevation-damage function.



The damage reach code is used to locate the appropriate reference flood elevations in the aggregation process. The adjustment in this case is -3 feet (668-671).

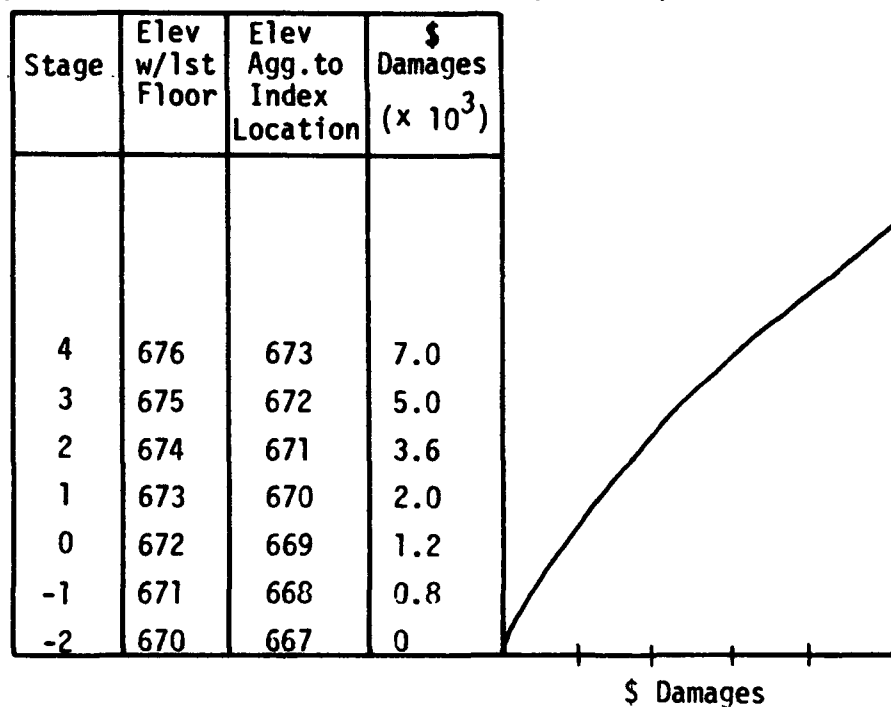


FIGURE 4-4
TRANSLATION OF THE GRID CELL ELEVATION-DAMAGE
FUNCTION TO THE DAMAGE REACH INDEX LOCATION

Elev	\$ Damages ($\times 10^3$)
673	7.0
672	5.0
671	3.6
670	2.0
669	1.2
668	0.8
667	0

Grid cell's aggregated elevation-damage function



Elev	\$ Damages ($\times 10^3$)
673	41.0
672	37.4
671	35.0
670	20.3
669	17.6
668	14.2
667	12.3
666	10.7
665	5.2
664	4.7
663	1.1
662	0

Land use 3's aggregated elevation-damage function prior to the sample cell being combined



Elev	\$ Damages ($\times 10^3$)
673	48.0
672	42.4
671	38.6
670	22.3
669	18.8
668	15.0
667	12.3
666	10.7
665	5.2
664	4.7
663	1.1
662	0

Resulting aggregated elevation-damage function for land use 3 until another grid cell (in damage reach 32 and with land use 3) is combined

FIGURE 4-5
DAMAGE AGGREGATION PROCESS

TABLE 4-3

AGGREGATED DAMAGE-FUNCTIONS
FOR DAMAGE REACH 32
AT THE INDEX LOCATION

Elev	Existing Land Use*					
	1	3	6	7	9	Total
654	0.0	0.0	0.0	0.0	0.0	0.0
655	0.5	0.0	0.1	0.0	0.0	0.6
656	1.2	0.0	0.4	0.0	0.0	1.6
657	1.4	0.0	0.4	0.0	0.1	1.9
658	1.5	0.0	0.4	0.0	0.1	2.0
659	1.6	0.0	0.4	0.0	0.1	2.1
660	1.9	0.0	0.4	0.0	0.1	2.4
661	2.4	0.0	0.4	0.0	0.1	2.9
662	2.8	1.1	0.4	1.2	0.2	5.7
663	3.1	5.5	0.4	1.2	0.2	10.4
664	3.2	14.7	0.4	20.4	0.2	38.9
665	3.4	19.9	0.4	86.1	0.2	110.0
666	3.7	26.8	0.4	175.9	0.3	207.1
667	4.0	36.4	0.4	267.5	0.3	308.6
668	4.2	47.9	0.4	325.1	0.4	378.0
669	4.4	71.6	0.4	372.2	0.4	449.0
670	4.5	81.4	0.5	410.6	0.4	497.4
671	4.6	91.0	0.5	442.8	0.5	539.4

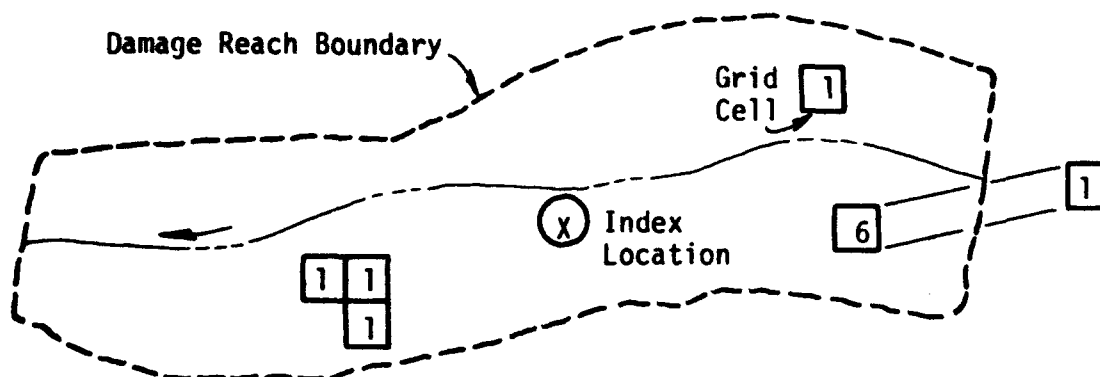
* Land Use Categories (Damages in thousands of dollars)

- 1 = Natural Vegetation
- 3 = Low Density Residential
- 6 = Agricultural
- 7 = Industrial
- 9 = Pasture

Nonstructural Measures

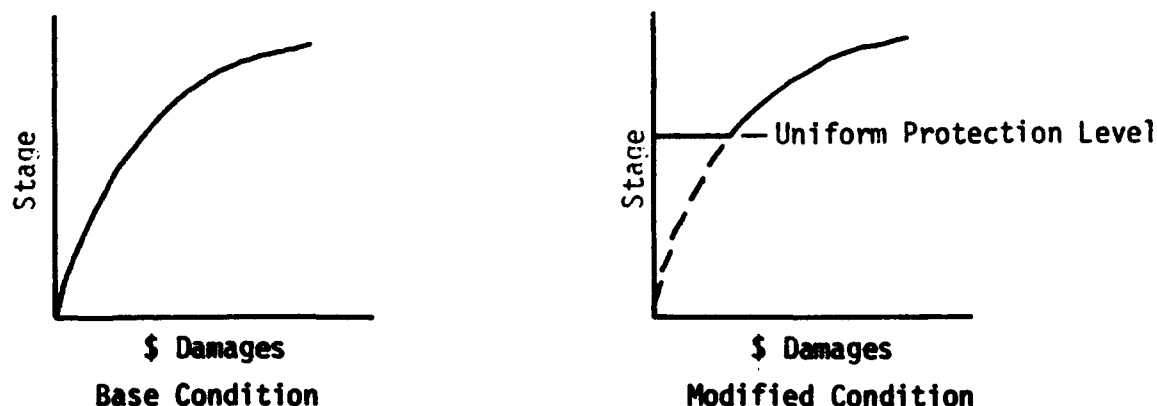
The evaluation of nonstructural flood damage reduction measures requires modification of the aggregated elevation-damage function, although a proposed measure may have little or no impact on the hydrologic response of the system (U.S. Army Corps of Engineers 1977). The DAMCAL computer program used to construct elevation-damage functions at damage reach index locations for existing and alternative land use patterns (as described in the preceding paragraphs) is also used in developing the damage functions for nonstructural measures. The types of nonstructural alternatives for which elevation-damage functions can be constructed are: 1) flood proofing specified land use categories a given number of feet above or below ground or first floor level (zero stage datum), 2) flood proofing specified land use categories to a uniform flood protection level, 3) temporary protection of structures and evacuation of contents in response to flood warning disseminations, 4) permanent relocation of structures within flood prone areas, and 5) regulatory policies restricting development in the flood plain. Each of the nonstructural alternatives is evaluated by modifying the appropriate land use category composite stage-damage function and/or the elevation-damage function of the grid cells affected.

Uniform Flood Proofing of a Land Use to a Specified Stage. The flood proofing of selected land use categories to specified stages results in the protection of all grid cells of the designated land use categories to predetermined heights. The assessment of potential flood damage reduction resulting from uniform flood proofing of this type is accomplished by directly modifying the input composite stage-damage function (see Table 4-2) or automatically (through the DAMCAL program) truncating the composite stage-damage function at the appropriate level. Figure 4-6 illustrates and describes the method used to perform the flood proofing assessment. As an example, consider the evaluation of flood proofing future development only. In a very simple land use alternative (used for purposes of clarity) the grid cell classified as land use 6 (existing or base condition) is converted



NOTE: Only selected grid cells are shown for clarity but in application the grid cells are exhaustive for the entire reach

COMPOSITE DAMAGE FUNCTIONS (Land Use Category 1)



GENERAL PROCEDURE FOR FLOOD PROOFING OPTION

1. If a uniform protection level is designated for land use category 1, then the composite damage functions of all grid cells assigned land use 1 are truncated to the specified protection level as shown. (It should be noted that the process could be repeated in the flood proofing of other land use categories).
2. An elevation-damage curve is then developed for each grid cell in the damage reach using the adopted and modified composite damage functions and assigning topographic elevations to the various stages (in the case of grid cell 1 the composite damage function would be the modified or truncated condition).
3. The elevation-damage curves are then adjusted based on the difference in reference flood elevations between individual grid cells and the index location and then aggregated according to land use classification.

FIGURE 4-6
FLOOD PROOFING SELECTED LAND USE CATEGORIES

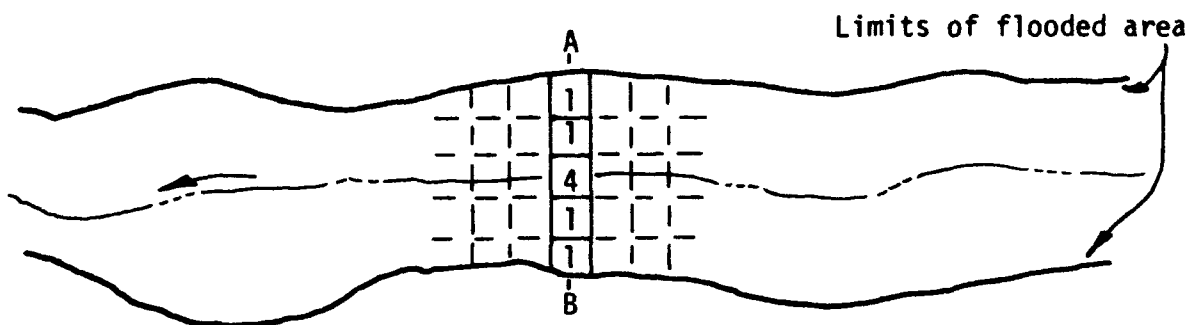
to land use 1 (future condition). In the aggregation process associated with future development, the base condition composite damage function would be used for the original four grid cells shown, whereas, a modified composite damage function would be used for the converted grid cell.

It is possible in a single computer run to uniformly flood proof as many land use categories as desired and to have a unique flood proofing level for each category.

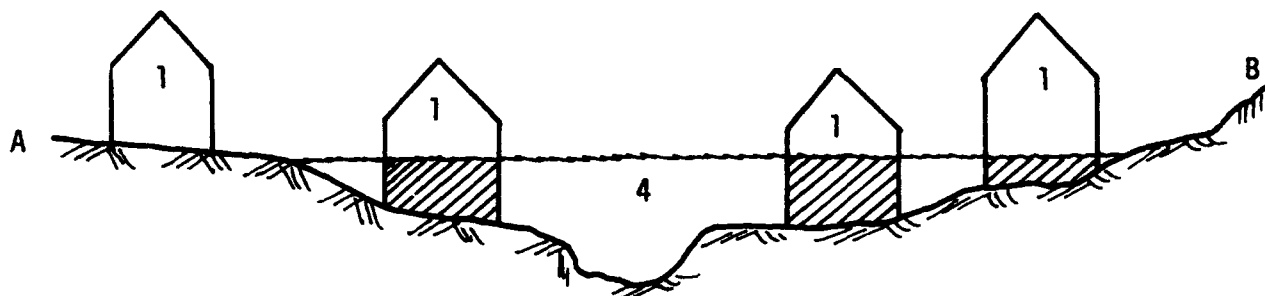
Flood Proofing to a Specified Protection Level. Flood proofing selected land uses to a specified protection level (within a given damage reach) requires the computation of the depth of flooding in each grid cell resulting from a flood event equivalent to the protection level specified. If a cell is inundated by that flood event, it is then flood proofed to an elevation corresponding to the depth of flooding. In general, flood proofing a damage reach to a particular frequency protection level would require some grid cells of a given land use category to be protected several feet, while others may need only the basements flood proofed or no protection at all (see Figure 4-7).

Construction of elevation-damage functions for this option is based on rating curve data (discharge versus stage or elevation) at the index locations. From a particular rating curve the elevation of the water surface at the index location which corresponds to the desired protection level is determined and input into the DAMCAL program. The corresponding protection level (elevation) is then computed for each grid cell using the reference flood, since changes in water surface elevation at the cell are consistent with changes in water surface elevation at the index location. (It should be remembered that damage reaches were defined based on essentially parallel water surface profiles). The flooded grid cells are subsequently flood proofed to protect against the specified event.

The computations are performed as follows: the reference flood elevation is subtracted from the target protection elevation at the index location



FLOODED AREA RESULTING FROM A
SPECIFIED FREQUENCY FLOOD EVENT



EXAMPLE CROSS SECTION A-B



Denotes depth of flood proofing required

1

Indicates low density housing

4

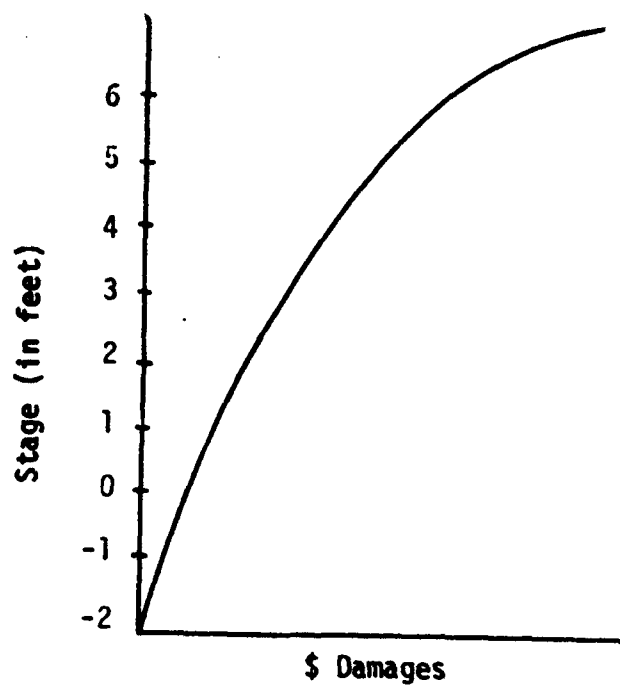
Indicates water body

FIGURE 4-7
FLOOD PROOFING REQUIRED FOR A TARGET
PROTECTION LEVEL

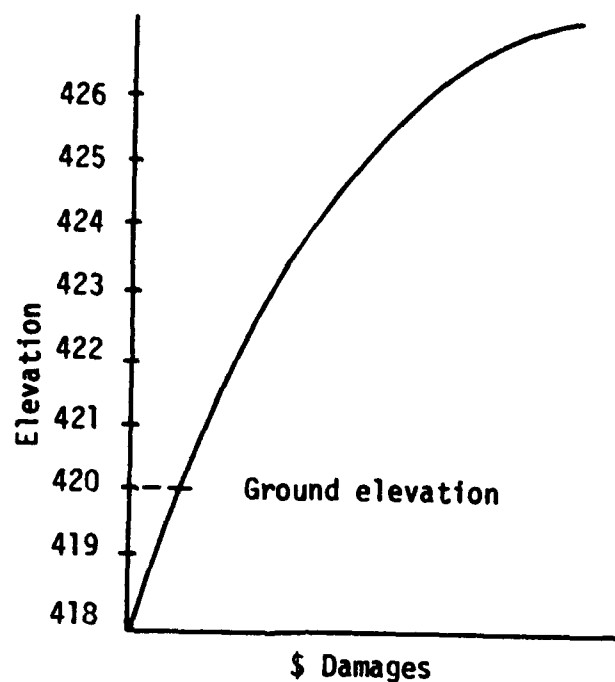
and the difference is added to the reference flood elevation of the grid cell. The computed elevation is the protection level water surface elevation. The amount of protection required for the grid cell is the protection elevation less the topographic (or ground) elevation. If the grid cell requires flood protection, the computer program truncates the elevation-damage curve at the protection level elevation. The process is repeated for each grid cell assigned to the damage reach.

Figure 4-8 illustrates the preceding computational procedure. The sample grid cell used has a ground elevation of 420.0 feet (see Figure 4-8b). The damage reach index location has a reference flood water surface elevation of 427.0 feet and a desired target protection level of 425.5 feet. The difference in water surface elevations at the index location is a minus 1.5 feet ($425.5 - 427.0$). The difference is added to the reference flood elevation of the grid cell to yield a corresponding target protection elevation ($424.5 - 1.5 = 423.0$ feet) for the cell (see Figure 4-8c). The elevation damage function is then truncated as shown in Figure 4-8d and aggregated to the index location in the usual manner. The option of flood proofing selected land use categories within a damage reach to various frequency flood events can be done for 1) existing conditions, 2) alternative land use conditions, and 3) alternative land use conditions considering the flood proofing of new development only.

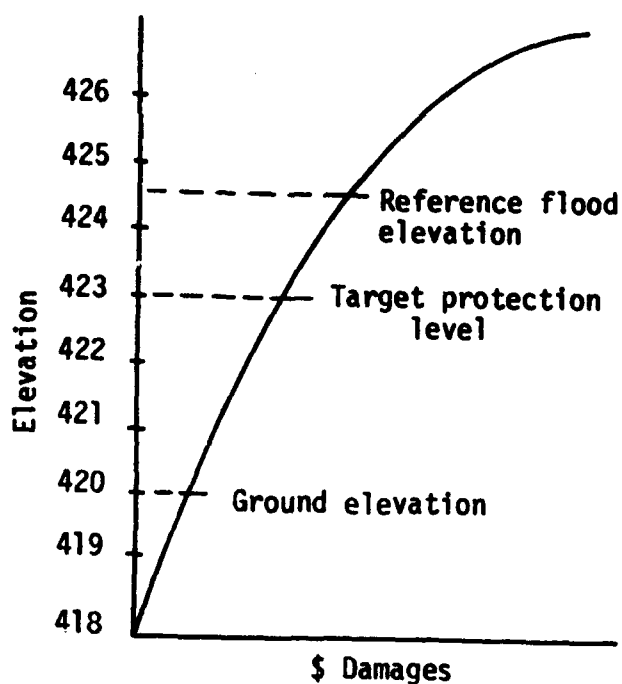
Response to Flood Warning Dissemination. The temporary evacuation of facilities within a damage reach is a component of the implementation of a flood warning system. This type of option is difficult to evaluate, not because of theory, but because it requires the estimation of the effect of a flood warning system on the stage-damage functions (for each land use category) as temporary protection measures are implemented. To evaluate the option, the stage-damage functions which are input to the DAMCAL program are modified (based on a percentage of the existing damage associated with each stage) for each damageable land use category that is affected. The modification in the stage-damage functions should include damage reduction



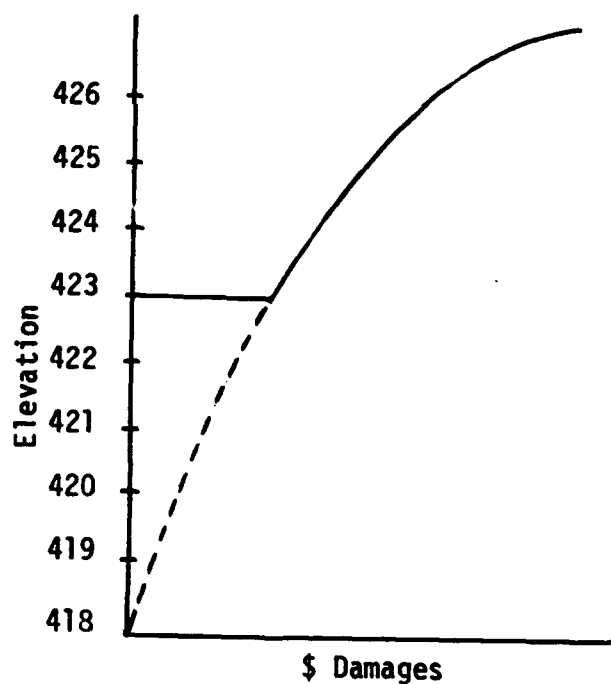
(a) Land Use Composite Stage-Damage Function



(b) Elevation-Damage Function of Grid Cell



(c) Elevation-Damage Function with Reference Flood and Target Protection Level



(d) Truncated Elevation-Damage Function for Grid Cell

FIGURE 4-8
GRID CELL DAMAGE FUNCTIONS
(TARGET PROTECTION LEVEL SPECIFIED)

to both the contents and the structure (a different percent reduction could be applied to each).

Since it is difficult to accurately estimate the damages reduced, several runs are made for different percent reductions of the composite damage functions to compute the break point necessary for the option to be cost effective. The cost effective possibilities are then evaluated to determine whether or not the level of damage reduction can be reasonably achieved. The evaluation of this optional flood damage reduction measure is done by directly modifying the composite stage-damage functions of the grid cell damage potential to an appropriate index location. This permits the flood warning option to be evaluated by itself or in combination with any of the other nonstructural alternatives.

Permanent Evacuation of the Flood Plain. The evaluation of permanent evacuation of the flood plain requires the spatial definition of the flood area and removal of all designated land uses from that area. In this option the reference flood is used for defining the flood plain in the same manner as described in the computation of flood proofing to a target protection level and permanent evacuation of a flood plain is in the development of the damage functions. Instead of a truncated elevation-damage function (as shown in Figure 4-8d), a no-damage (or a specified damage) function is aggregated to the index location.

Figure 4-9 (a reproduction of Figure 4-8c) is used to illustrate several important aspects related to permanent evacuation of a flood plain area. If the flood plain elevation computed for the grid cell is 423.0 feet (Flood #1 of Figure 4-9) then the land use occupying the grid cell would be removed and a no-damage potential (or a specified damage potential for a grid cell exhibiting less damageable properties) would be aggregated to the index location. If though, Flood #2 (a water surface elevation of 419.0 feet) is used to compute the flooded area to be evacuated, then the grid cell is considered outside the flood plain of interest (grid cell ground elevation above the computed elevation for Flood #2). An inspection

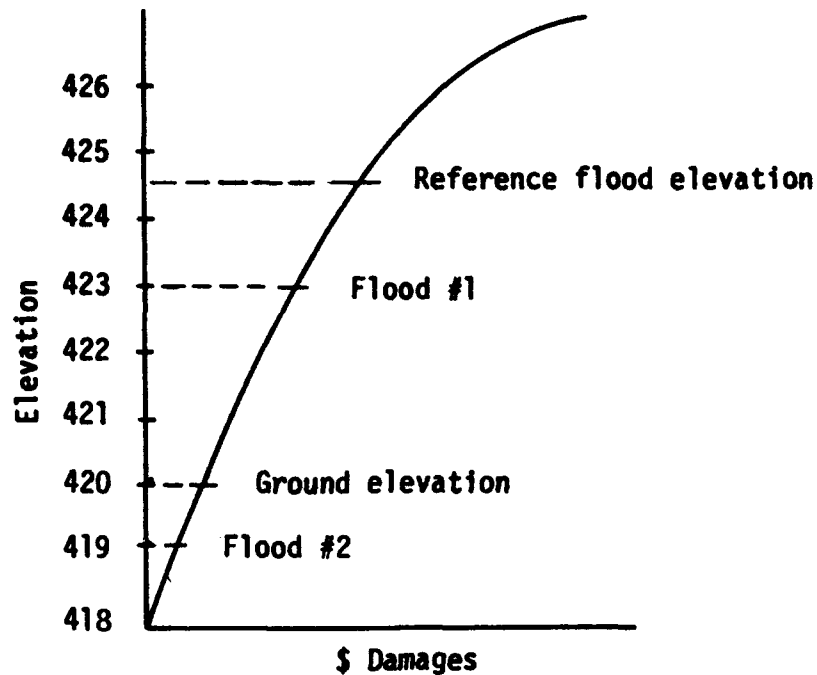


FIGURE 4-9
MULTIPLE FLOOD ELEVATIONS IN
CONJUNCTION WITH PERMANENT EVACUATION OF THE
FLOOD PLAIN

of Figure 4-9, in this case, indicates that the grid cell would still incur damages if Flood #2 occurred. The DAMCAL program has two options to permit analysis of the preceding flood plain conditions: 1) to permanently evacuate all grid cells for designated land use categories that are in the flood plain or 2) to evacuate all grid cells (of the designated land use categories) that incur damages due to the flood event of interest. If the latter option is used for the grid cell shown in Figure 4-9, then the cell land use would be removed in the case of Flood #2.

Flood Plain Regulation. Flood plain regulation is the zoning of the flood plain to restruct encroachment by major damageable land uses. In general, if a damageable land use is placed within the flood plain, then fill or some other means must be used to raise the first floor elevation above

the flood plain elevation. It is desirable, therefore, to evaluate the effect flood plain regulation has on potential flood damage reduction. The effectiveness of flood plain regulation in reducing potential damage is determined by constructing aggregated elevation-damage curves at each index location for the future land use pattern and the future land use pattern with the regulatory policy in effect. The aggregated elevation-damage curves are then used as the basis for comparison.

When a land use pattern is subjected to flood plain regulation, the analysis makes use of the reference flood to determine the flood plain of interest. The elevation of the regulatory flood (flood plain of interest) at the index location is determined by a method similar to that for flood proofing damage reaches to a specified protection level. If the computed regulatory flood event water surface elevation is higher than the topographic elevation of the grid cell, the elevation-damage function for the grid cell is elevated so that the ground elevation (or zero stage) is the same as the flood event water surface elevation. The corresponding change in the elevation-damage function is shown in Figure 4-10 (based on the grid cell example of Figure 4-8c). For a regulatory elevation of 423.0 feet, the elevation-damage function must be raised 3 feet to reflect the placement of ground elevation or zero stage at or above the regulated flood plain.

Even though a grid cell has its ground elevation (or zero stage) moved above a flood plain, it can still incur damages from the flood plain event. To accommodate this, the DAMCAL program has the capability to place the ground elevation or the zero-damage elevation at the flood plain elevation. Table 4-4 is an example taken from the Trail Creek Watershed (U.S. Army Corps of Engineers, 1975) comparing expected annual damages with and without flood plain regulation. The comparison is made for a 1990 future land use pattern with 1) no flood plain regulation, 2) flood plain regulation in which the ground elevation of new development must be constructed above the 100-year flood plain, and 3) flood plain regulation in which new development is required to position the zero-damage elevation above the 100-year flood plain.

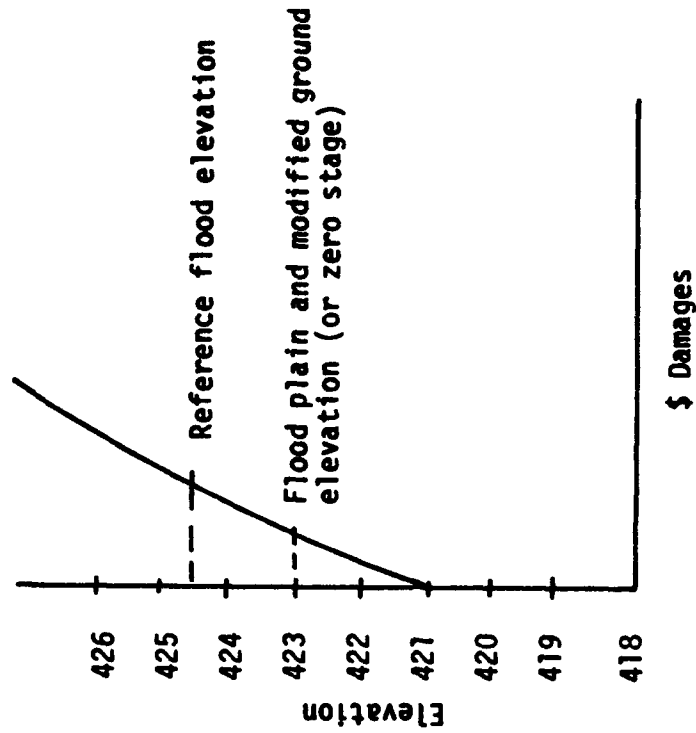
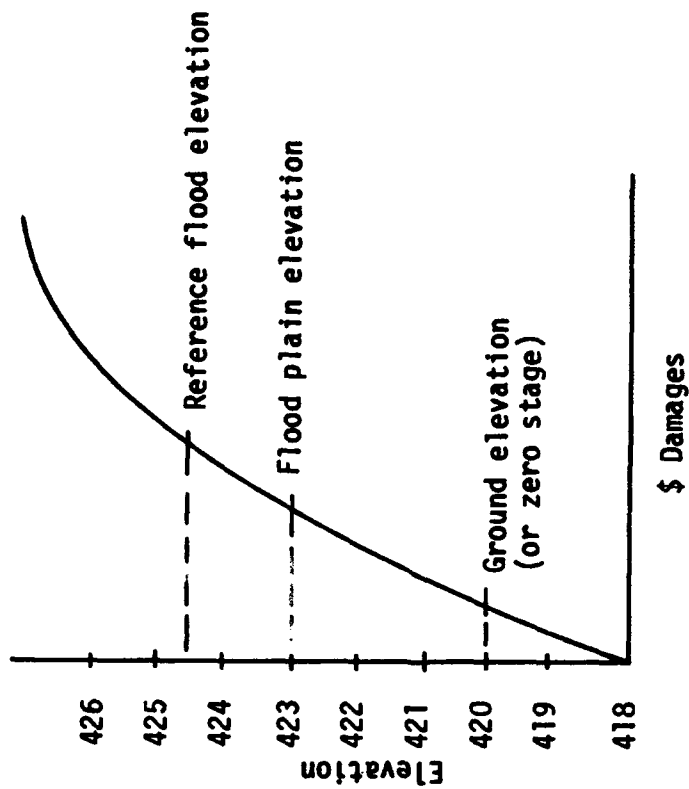


FIGURE 4-10
GRID CELL ELEVATION-DAMAGE FUNCTION ADJUSTMENT
FOR FLOOD PLAIN REGULATION

(It should be noted from Table 4-4 that a significant reduction in potential damage results from possible flood plain regulation).

TABLE 4-4

COMPARISON OF EXPECTED ANNUAL DAMAGE
(in 1000's pf dollars)

Evaluation Condition	Damage Reach #1	Damage Reach #2	Damage Reach #3
Existing Land Use	1.5	2.5	12.0
1990 Land Use without Flood Plain Regulation	1033.3	350.0	32.7
1990 Land Use with Ground Elevation Regulation	19.3	63.8	23.8
1990 Land Use with Zero-Damage Regulation	9.2	6.7	3.0

The evaluation of flood plain regulation is not restricted to a 100-year flood plain, and it could be an alternative which is evaluated singularly or in combination with other flood proofing alternatives. For example, a combination of alternatives could place structures above the 75-year flood plain and uniformly flood proof to the 100-year flood event elevations.

Single Event Computation

DAMCAL has the capability to calculate damages which would occur for several specified frequency flood events while the program is aggregating damages to the index location. The capability is extremely useful because it eliminates errors which can occur when a user attempts to interpolate between elevation-damage values.

To illustrate the potential problem, Table 4-5 shows damages for a particular land use category at several elevations. If the 50-year flood event for the index location is 637.5 feet, a user might interpolate linearly between the elevations of 637 and 638 feet in estimating the damages at \$37,000. What is not known is whether the value of \$62,000 for an elevation of 638 feet represents a large number of grid cells with a tenth of a foot of flooding or if a small number of cells were experiencing greater depths of flooding. In the former case an elevation of 637.5 could result in a relatively insignificant increase in damages from that shown at an elevation of 637 feet (\$12,000). In the latter case the \$37,000 estimate could be a reasonable approximation of the damages due to a 50-year flood event.

TABLE 4-5

AGGREGATED ELEVATION-DAMAGE VALUES FOR A
PARTICULAR LAND USE CATEGORY

Elevation	\$ Damages ($\times 10^3$)
640	120
639	65
638	62
637	12
636	10
635	0

In addition to the computation of damages for single events, the DAMCAL program creates a computer file which contains the grid cell location, the depth of flooding, the dollar damages, and the land use for each single event run. The information can be used to plot depth of flooding versus resulting damages or to partition damages by land use as an aid in determining the effect different flood plain management schemes would have on reducing the damage potential. The plotting of single event damages or flooded area displays can be accomplished using the RIA computer program (U.S. Army Corps of Engineers 1977).

Future Program Additions. Planned additions include 1) an automated damage function file transfer to the Expected Annual Flood Damage Computation (EAD) program (U.S. Army Corps of Engineers 1977) and 2) integration with the Structure Inventory of Damages (SID) computer program data file (Davis and Webb 1978). The former added capability will permit use of the comprehensive EAD program for detailed benefit studies and the latter added capability will permit the evaluation of unique damageable properties external to the grid cell data bank and the DAMCAL program without a double accounting of the damage potential. The need for additional features should be addressed to the Hydrologic Engineering Center.

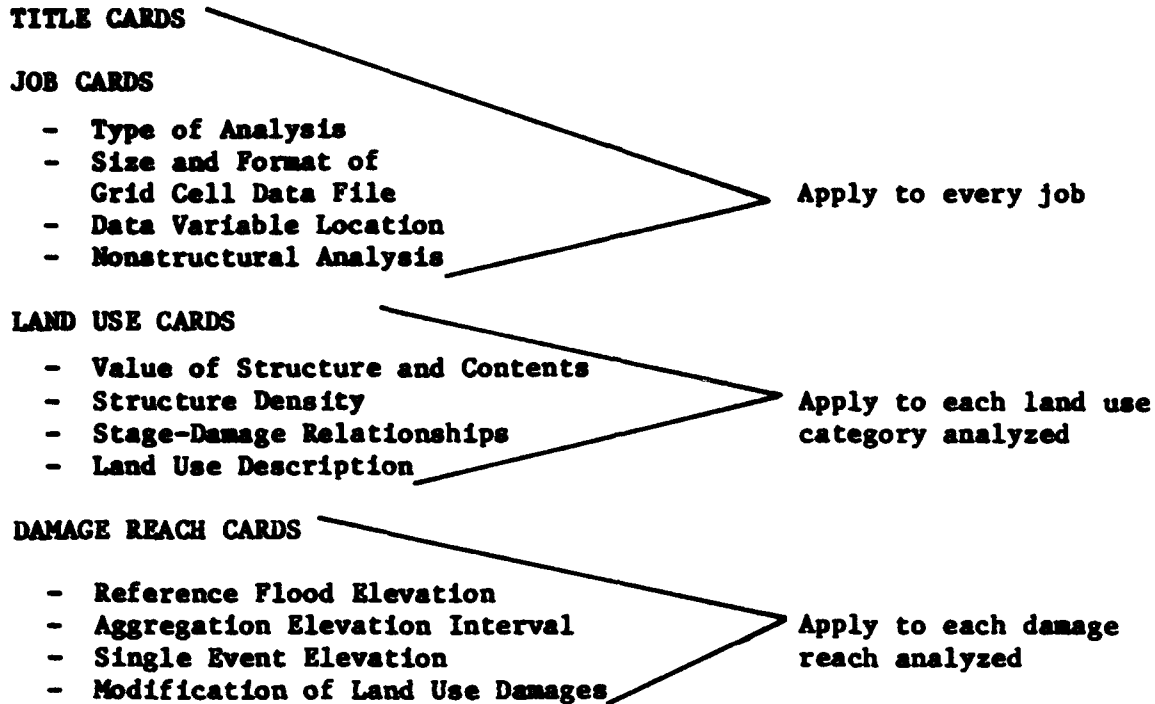
Input Preparation

General Description. The following material describes the data (for the DAMCAL computer program) which are entered on each input card and the type of cards needed for the desired analysis to be performed.

The program is flexible to a degree in the data that can be input for analysis and in the detail of the output desired. Some of the input cards are optional and need not be provided unless required by the particular option which is specified.

Program Data Hierarchy. The general hierarchy of the major data types in this program is displayed in Table 4-6.

TABLE 4-6
PROGRAM DATA HIERARCHY



Data Card Description

Title Cards, T1, T2, T3. The title cards are required and they provide output display information that can readily identify the project and the particular job. The content of the title cards is optional, but it is suggested that they include a record of the project name, data notes, selected program options, and any unique features of the job. A numbering system that accounts for the job run for a particular project would prove useful. The information on the title cards is printed, in general, at the top of each page of the computer printout.

First Job Card, J1. This required card specifies the type of analysis to be performed (flood proofing, evacuation, single event, etc.), the printout

option and the file management option. The files generated by DAMCAL can be used as input to the ATODTA program (discussed in Section 5 of this report) and as input to the RIA computer program (U.S. Army Corps of Engineers, 1977) for flooded area displays.

Second Job Card, J2. This required card describes the computer file location of the data bank, the number of data variables, the dimensions of the data base, and whether or not the grid cell data bank is formatted.

Third Job Card, J3. This required card defines the sequence numbers of the data variables used in the analysis and the number of categories for particular data variables.

Fourth Job Card, J4. An optional card(s) used only when land use categories will have new development or all development raised above a specified flood level at the damage reach index location.

Fifth Job Card, J5. An optional card(s) used to specify land use categories that will be flood proofed.

Sixth Job Card, J6. An optional card(s) used to specify the depth of flood proofing for each of the land use categories listed on the J5 card(s).

Seventh Job Card, J7. An optional card(s) used to specify land use categories that will be permanently evacuated.

Eighth Job Card, J8. An optional card used to identify the damage reach and land use within that damage reach for which trace printout is desired. (The printout is utilized primarily in determining coding and computational problems).

Format Card, FT. An optional card used to describe the format of a formatted data bank.

Single Flood Event Title Card, ST. An optional card containing the titles of the single flood events.

Composite Land Use Cards, LU, LT, DF, DS, DC, DO, DD. One set of composite land use cards is required for each land use category within the study area.

- Land Use Damage Card LU. A required card utilized at the start of each set of composite land use cards. The card, in general, contains information necessary to determine the composite stage damage relationship for a given land use category.
- Land Use Title Card, LT. A required card needed after each LU card. The card provides the land use title and the zero stage adjustment for the land use category described on the preceeding LU card.
- Depth of Flooding Card, DF. A required card(s) used to assign depth of flooding values to the composite stage-damage function of each land use category.
- Damage to Structure, Contents and Other Cards, DS, DC, DO. Optional card(s) utilized only if the DAMCAL program is used to construct the stage-damage function for a specified land use category. The cards contain the percent damage to structure (DS), to contents (DC), and to other (DO) associated with each depth value entered on the DF card(s). The damage to other category, DO card(s), is used either to capture indirect damages or to separate out unique content damages.
- Total Damage Card, DD. An optional card(s) used if the stage-damage relationship for a land use category has been previously computed (the DAMCAL program will not be used to construct the stage-damage function).

Damage Reach Cards, DR, DT, SE, LC. A set of damage reach cards is required for each damage reach in the analysis run.

- Damage Reach Card, DR. A required card needed to identify the damage reach code in the data bank and to give the corresponding reference flood elevation, the starting aggregation elevation, the aggregation interval and any policy, flood proofing or evacuation elevations that are necessary. The DR card is also used to create a new damage reach from the aggregation of the current damage reach and to modify land use densities and other input values.
- Damage Reach Title Card, DT. A required card needed after the DR card to describe the current damage reach.
- Single Flood Event Card, SE. An optional card necessary only for single flood event analysis. The card values represent the water surface elevations at the damage reach index location which correspond to the single flood events described on the ST card.
- Change to Land Use Damage Card, LC. An optional card(s) used to modify damage data for a specified land use(s) within the damage reach.

Ending Card, END. A required card that signals the end of the input data.

Output Display

The description of the output is accompanied by a sample printout, Exhibit 4-1. The output does not include all land use category damage functions or damage reach aggregated damage functions which would normally be printed. The numbers in parenthesis in the text refer to a specific line (or series of lines) that is numbered on the sample output.

Input Listing. A display of the input deck, pages 1 and 2 of Exhibit 4-1, is provided at user request (1).

Title. The information on the title cards is, in general, printed at the top of each output page (2).

Job Cards. The data on the job cards are first displayed in a card image format prior to a more descriptive definition of the variables. The variable and input values follow with a brief description of each variable.

- Analysis Information, J1 Card. An image of the required J1 card is displayed (3) and a description of the coded input values given (4).
- Data Bank Information, J2 Card. The required J2 card is shown in card image form (5) and the values that define the location, format, and size of the data bank are displayed and identified (6).
- Data Variable Information, J3 Card. The required J3 card is reproduced (7) and the values that define the data variables in the data bank are displayed and identified (8).
- Policy Data, J4, J5, J6, J7 Cards. The land use categories, whether existing or new development, subject to policy controls, flood proofing and permanent evacuation are shown (9).
- Trace Information, J8 Card. The damage reach and land use category to be displayed as trace output are indicated (10). The option generally would not be requested by the user.

Format Data. Since the DATA BANK is formatted, a format statement is provided in the output (11).

Composite Land Use Damage Data. The damage data relating to each land use category (as input) is printed out in tabular form as follows:

- Land Use Identifier. The land use category number is provided and is followed by the description or title (12).
- Damage Data. The values used to determine the damage function for each land use category are tabulated in the output. The column titles are related to the input variables as shown below:

DEPTH OF WATER - DEPTH (I), DF Card (13).

PERCENT DAMAGE STRUCTURE - DS(I), DS Card (14).

PERCENT DAMAGE CONTENTS - DC(I), DC Card (15).

PERCENT DAMAGE OTHER - DO(I), DO Card (16).

AMOUNT OF DAMAGE PER GRID CELL IN THOUSAND DOLLARS - Values for each grid cell of this land use category are calculated by the program (17).

- Land Use Information. The output reflects the information provided on the LU Card. The order of output follows:

DENSITY OF LAND USE, UNITS PER GRID CELL - DENSITY, LU Card (18).

BASE VALUE OF STRUCTURE - BASEVAL, LU Card (19)

BASE VALUE OF THE CONTENTS - BASEVLU, LU Card (20).

TOTAL DAMAGE OF OTHER WILL BE THE RESPECTIVE PERCENTAGE OF THE TOTAL - BASEIND, LU Card (21).

VACANCY FACTOR (PERCENT DEVELOPED) - VACNCY, LU Card (22).

Damage Reach Index Location Summary. The data printed in the damage reach index location summary reflect the sequence of information input on the DR card(s). For each damage reach a value is given to each of the program variables listed below:

ID. NO., the identification number for the damage reach - JDR(I), DR Card (23).

REFERENCE FLOOD ELEVATION, the reference flood water surface elevation at the index location - REFFLD(I), DR Card (24).

POLICY FLOOD ELEVATION, the water surface elevation at the index location indicating the policy level - POLELV(I), DR Card (25).

FLOOD PROOFING ELEVATION, the water surface elevation at the index location indicating the level to be protected by floodproofing - PROELV(I), DR Card (26).

EVACUATION ELEVATION, the water surface elevation at the index location indicating the level of permanent evacuation - EVCELV(I), DR Card (27).

STARTING DAMAGE ELEVATION, the water surface elevation at the index location where the aggregated elevation damage functions begins - STRELV(I), DR Card (28).

DAMAGE ELEVATION INCREMENT, the increment between the water surface elevations for the calculation of damages at the index location - ELVINT(I), DR Card (29).

AGGREGATED DAMAGE REACH ID., the identifier of the new damage reach resulting from the aggregation of this damage reach - IAGGDR(I), DR Card (30).

MODIFY LAND USE DENSITY, the identifier to modify land use density and damage values - IMODFY(I), DR Card (31).

Single Events for Damage Reaches. When a single flood event analysis is performed, then the following information is printed out for each specified flood event:

- Title. The output reflects the information provided on the ST card (32).

- **Water Surface Elevations.** The water surface elevations at the index location indicating the flood levels of the flood events under analysis. The data is input on the SE card (33).

Trace Information as Specified on the J8 Card. As specified on the J8 card, grid cells designated as land use category 4 and within damage reach 1 are traced (34). In this particular case the trace provided information on two grid cells only. For each of these grid cells the program computes the adjusted elevation-damage function at the index location (35) and then accumulates the damages as each additional grid cell is analyzed (36).

Aggregated Damage Output. The following output is produced when the elevation-damage functions for all grid cells within a given damage reach are aggregated to the corresponding index location:

- **Grid Cells Affected by Nonstructural Options.** A listing is provided of those grid cells affected by the nonstructural options specified within the damage reaches analyzed (37).
- **Minimum/Maximum Damage Levels.** The grid cells that lie above or below the maximum and minimum water surface elevations specified at the index location for the computation of the aggregated elevation-damage function are identified (38). Grid cells with damages that start above the maximum damage elevation are not included in the aggregation process, whereas, grid cells with damages that start below the minimum damage elevation are truncated (only grid cell damages occurring between the minimum and maximum levels are included in the aggregation process).
- **Damage Reach Identification.** Each damage reach analyzed is identified by number and title (39).

- Aggregated Elevation Damage. A table of aggregated damages shows the dollar amount of damage (in thousands of dollars) for each land use category for various levels of water surface elevation at the index station location (40). Total damages for each water surface elevation increment are given in the far right column. Single event damages (as specified on the ST card) are also included in the table. (A similar table is provided for every damage reach analyzed).
- Damage-Land Use Table. The table relates the damage category value and land use code value to the appropriate land use category (41).

Sample Problems

Sample problems illustrating various types of calculations currently available utilizing the DAMCAL computer program are included in Exhibits 4-2, 4-3, 4-4, 4-5 and 4-6. The sample input and output will provide the user with an overall description of the data necessary for program execution. The sample problems will also provide a valid data set to verify program operations on other computer systems. The necessary data input categories and codes used from the Trail Creek data bank are incorporated in each of the problems. (It should be noted that the output displays for Exhibits 4-3, 4-4, 4-5 and 4-6 are incomplete. Stage-damage data are given for only one of the ten land use categories in the Trail Creek watershed).

REFERENCES

- Davis, Darryl W. and Webb, R. Pat, May 1978, Flood Damage Assessments Using Spatial Data Management Techniques, The Hydrologic Engineering Center, Davis, California.
- U.S. Army Corps of Engineers, September 1975, Phase I Oconee Basin Pilot Study - Trail Creek Test, The Hydrologic Engineering Center, Davis, California.
- U.S. Army Corps of Engineers, June 1977, Expected Annual Flood Damage Computation, The Hydrologic Engineering Center, Davis, California.
- U.S. Army Corps of Engineers, September 1978, Resource Information and Analysis, The Hydrologic Engineering Center, Davis, California.
- U.S. Army Corps of Engineers, September 1978, Guide Manual for the Creation of Grid Cell Data Banks, The Hydrologic Engineering Center, Davis, California.

EXHIBIT 4-1

**OUTPUT DISPLAY
DAMCAL-STAGE DAMAGE CALCULATION**

(2) Title

(3) J1 card image

(6) Display of J1 card values

AVIAL VOIS INFORMATION

2, SPECIFIED NEW DEVELOPMENT WILL HAVE THEIR GROUND FLOOD PLACED ABOVE A POLICY LEVEL

IF ONLY A, SPECIFIED NEW DEVELOPMENT WILL BE FLOOD PROTECTED TO A SPECIFIED LEVEL

EVAC 2, EVACUATE ALL NEW DEVELOPMENT WHICH HAS ITS GROUND LEVEL IN THE RESTRICTED FLOOD PLAIN

1, EVACUATED CELLS WILL BE AGGREGATED INTO THIS LAND USE CATEGORY

TRACE # 1, TRACE OUTPUT REQUESTED

SAINTO = O, NO FILL CREATED FOR ATUNIA PROGRAM

1. NAME OF THE PARTY: **DEMOCRATIC PARTY**

2. NAME OF THE CANDIDATE: **JOHN F. KENNEDY**

3. NAME OF THE CHAIRMAN: **JOHN F. KENNEDY**

4. NAME OF THE SECRETARY: **JOHN F. KENNEDY**

5. NAME OF THE TREASURER: **JOHN F. KENNEDY**

6. NAME OF THE MANAGER: **JOHN F. KENNEDY**

7. NAME OF THE ASSISTANT MANAGER: **JOHN F. KENNEDY**

8. NAME OF THE CHIEF OF STAFF: **JOHN F. KENNEDY**

9. NAME OF THE CHIEF OF CAMPAIGN: **JOHN F. KENNEDY**

10. NAME OF THE CHIEF OF POLITICAL: **JOHN F. KENNEDY**

11. NAME OF THE CHIEF OF LEGAL: **JOHN F. KENNEDY**

12. NAME OF THE CHIEF OF FINANCIAL: **JOHN F. KENNEDY**

13. NAME OF THE CHIEF OF PUBLIC RELATIONS: **JOHN F. KENNEDY**

14. NAME OF THE CHIEF OF COMMUNICATIONS: **JOHN F. KENNEDY**

15. NAME OF THE CHIEF OF RESEARCH: **JOHN F. KENNEDY**

16. NAME OF THE CHIEF OF ANALYSIS: **JOHN F. KENNEDY**

17. NAME OF THE CHIEF OF STRATEGY: **JOHN F. KENNEDY**

18. NAME OF THE CHIEF OF TACTICS: **JOHN F. KENNEDY**

19. NAME OF THE CHIEF OF LOGISTICS: **JOHN F. KENNEDY**

20. NAME OF THE CHIEF OF SUPPORT: **JOHN F. KENNEDY**

21. NAME OF THE CHIEF OF SECURITY: **JOHN F. KENNEDY**

22. NAME OF THE CHIEF OF PROTECTION: **JOHN F. KENNEDY**

23. NAME OF THE CHIEF OF DEFENSE: **JOHN F. KENNEDY**

24. NAME OF THE CHIEF OF OFFENSE: **JOHN F. KENNEDY**

25. NAME OF THE CHIEF OF WAR: **JOHN F. KENNEDY**

26. NAME OF THE CHIEF OF PEACE: **JOHN F. KENNEDY**

27. NAME OF THE CHIEF OF LOVE: **JOHN F. KENNEDY**

28. NAME OF THE CHIEF OF HATE: **JOHN F. KENNEDY**

29. NAME OF THE CHIEF OF GOOD: **JOHN F. KENNEDY**

30. NAME OF THE CHIEF OF EVIL: **JOHN F. KENNEDY**

31. NAME OF THE CHIEF OF LIGHT: **JOHN F. KENNEDY**

32. NAME OF THE CHIEF OF DARKNESS: **JOHN F. KENNEDY**

33. NAME OF THE CHIEF OF LIFE: **JOHN F. KENNEDY**

34. NAME OF THE CHIEF OF DEATH: **JOHN F. KENNEDY**

35. NAME OF THE CHIEF OF HEAVEN: **JOHN F. KENNEDY**

36. NAME OF THE CHIEF OF EARTH: **JOHN F. KENNEDY**

37. NAME OF THE CHIEF OF WATER: **JOHN F. KENNEDY**

38. NAME OF THE CHIEF OF FIRE: **JOHN F. KENNEDY**

39. NAME OF THE CHIEF OF AIR: **JOHN F. KENNEDY**

40. NAME OF THE CHIEF OF SPACE: **JOHN F. KENNEDY**

41. NAME OF THE CHIEF OF TIME: **JOHN F. KENNEDY**

42. NAME OF THE CHIEF OF SPACE-TIME: **JOHN F. KENNEDY**

43. NAME OF THE CHIEF OF MATTER: **JOHN F. KENNEDY**

44. NAME OF THE CHIEF OF ENERGY: **JOHN F. KENNEDY**

45. NAME OF THE CHIEF OF INFORMATION: **JOHN F. KENNEDY**

46. NAME OF THE CHIEF OF KNOWLEDGE: **JOHN F. KENNEDY**

47. NAME OF THE CHIEF OF WISDOM: **JOHN F. KENNEDY**

48. NAME OF THE CHIEF OF UNDERSTANDING: **JOHN F. KENNEDY**

49. NAME OF THE CHIEF OF FAITH: **JOHN F. KENNEDY**

50. NAME OF THE CHIEF OF HOPE: **JOHN F. KENNEDY**

51. NAME OF THE CHIEF OF CHARITY: **JOHN F. KENNEDY**

52. NAME OF THE CHIEF OF COURAGE: **JOHN F. KENNEDY**

53. NAME OF THE CHIEF OF PATIENCE: **JOHN F. KENNEDY**

54. NAME OF THE CHIEF OF KINDNESS: **JOHN F. KENNEDY**

55. NAME OF THE CHIEF OF GENTLENESS: **JOHN F. KENNEDY**

56. NAME OF THE CHIEF OF MEANNESS: **JOHN F. KENNEDY**

57. NAME OF THE CHIEF OF PRIDE: **JOHN F. KENNEDY**

58. NAME OF THE CHIEF OF ENVY: **JOHN F. KENNEDY**

59. NAME OF THE CHIEF OF JEALOUSY: **JOHN F. KENNEDY**

60. NAME OF THE CHIEF OF WRATH: **JOHN F. KENNEDY**

61. NAME OF THE CHIEF OF SLOTH: **JOHN F. KENNEDY**

62. NAME OF THE CHIEF OF GLUTTONY: **JOHN F. KENNEDY**

63. NAME OF THE CHIEF OF DRUNKENNESS: **JOHN F. KENNEDY**

64. NAME OF THE CHIEF OF FLESHLINESS: **JOHN F. KENNEDY**

65. NAME OF THE CHIEF OF SATAN: **JOHN F. KENNEDY**

66. NAME OF THE CHIEF OF DEVIL: **JOHN F. KENNEDY**

67. NAME OF THE CHIEF OF SIN: **JOHN F. KENNEDY**

68. NAME OF THE CHIEF OF CRIME: **JOHN F. KENNEDY**

69. NAME OF THE CHIEF OF LAW: **JOHN F. KENNEDY**

70. NAME OF THE CHIEF OF JUSTICE: **JOHN F. KENNEDY**

71. NAME OF THE CHIEF OF ORDER: **JOHN F. KENNEDY**

72. NAME OF THE CHIEF OF CHAOS: **JOHN F. KENNEDY**

73. NAME OF THE CHIEF OF HARMONY: **JOHN F. KENNEDY**

74. NAME OF THE CHIEF OF DISHARMONY: **JOHN F. KENNEDY**

75. NAME OF THE CHIEF OF UNITY: **JOHN F. KENNEDY**

76. NAME OF THE CHIEF OF DIVISION: **JOHN F. KENNEDY**

77. NAME OF THE CHIEF OF COMBINATION: **JOHN F. KENNEDY**

78. NAME OF THE CHIEF OF SEPARATION: **JOHN F. KENNEDY**

79. NAME OF THE CHIEF OF CONNECTION: **JOHN F. KENNEDY**

80. NAME OF THE CHIEF OF ISOLATION: **JOHN F. KENNEDY**

81. NAME OF THE CHIEF OF COMMUNITY: **JOHN F. KENNEDY**

82. NAME OF THE CHIEF OF SOCIETY: **JOHN F. KENNEDY**

83. NAME OF THE CHIEF OF CULTURE: **JOHN F. KENNEDY**

84. NAME OF THE CHIEF OF ARTS: **JOHN F. KENNEDY**

85. NAME OF THE CHIEF OF SCIENCE: **JOHN F. KENNEDY**

86. NAME OF THE CHIEF OF TECHNOLOGY: **JOHN F. KENNEDY**

87. NAME OF THE CHIEF OF INNOVATION: **JOHN F. KENNEDY**

88. NAME OF THE CHIEF OF TRADITION: **JOHN F. KENNEDY**

89. NAME OF THE CHIEF OF HERITAGE: **JOHN F. KENNEDY**

90. NAME OF THE CHIEF OF HISTORY: **JOHN F. KENNEDY**

91. NAME OF THE CHIEF OF GEOGRAPHY: **JOHN F. KENNEDY**

92. NAME OF THE CHIEF OF CLIMATE: **JOHN F. KENNEDY**

93. NAME OF THE CHIEF OF WEATHER: **JOHN F. KENNEDY**

94. NAME OF THE CHIEF OF ENVIRONMENT: **JOHN F. KENNEDY**

95. NAME OF THE CHIEF OF NATURE: **JOHN F. KENNEDY**

96. NAME OF THE CHIEF OF COSMOS: **JOHN F. KENNEDY**

97. NAME OF THE CHIEF OF UNIVERSE: **JOHN F. KENNEDY**

98. NAME OF THE CHIEF OF GALAXY: **JOHN F. KENNEDY**

99. NAME OF THE CHIEF OF PLANET: **JOHN F. KENNEDY**

100. NAME OF THE CHIEF OF EARTH: **JOHN F. KENNEDY**

ISTRUC

Exhibit 4-1
3 of 11

J2 CARD

CC 123456789012345678901234567890123456789012345678901234567890
J2 1 1 18 92 120 1

(5) J2 card image

(6) Display of J2 card values

DATA BANK INFORMATION

MFILE = 1, THE DATA BANK IS ON THIS COMPUTER UNIT
MFORM = 1, THE DATA BANK IS FORMATTED
NDV = 10, THE NUMBER OF DATA VARIABLES
IRDM = 92, THE NUMBER OF ROWS IN THE DATA BANK
ICUL = 129, THE NUMBER OF COLUMNS IN THE DATA BANK
THAGE = 1, PRINTED IMAGE OF INPUT DECK

J3 CARD

CC 123456789012345678901234567890123456789012345678901234567890
J3 1 1 11 10 14 13 31

(7) J3 card image

(8) Display of J3 card values

DATA VARIABLE INFORMATION

TUAMPC = 5, THE DATA VARIABLE THAT IS THE DAMAGE MEACH COOL
NIOR = 2, THE NUMBER OF DAMAGE REACHES IN THIS ANALYSIS
ILAND = 11, THE DATA VARIABLE THAT IS THE LAND USE ANALYZED
THASE = 10, THE DATA VARIABLE CONSIDERED THE BASE COMPUTATION
NOLUC = 10, THE NUMBER OF LAND USE CATEGORIES
ITOPD = 14, THE DATA VARIABLE THAT IS TOPOGRAPHY
INFPD = 13, THE DATA VARIABLE THAT IS THE REFERENCE FLOOD ELEVATION
TELV = 31, THE NUMBER OF ELEVATION-DAMAGE POINTS TO BE CALCULATED

OUTPUT DISPLAY
DAMAGE-STAGE DAMAGE CALCULATION
DECEMBER 1978

LAND USE CATEGORY NO. 3

(12) Land use identifier

LOW DENSITY HOUSING

(13)	(14)	(15)	(16)	(17)
DEPTH OF WATER	PERCENT OF STRUCTURES	PERCENT DAMAGE CONTENTS	PERCENT DAMAGE OTHER	AMOUNT OF DAMAGE PER GRID CELL IN THOUSAND DOLLARS
-2.01	0.	0.	0.	0.
-2.00	1.00	0.	5.00	.15
-1.00	1.00	0.	5.00	.15
0.	10.00	2.00	5.00	1.59
1.00	13.00	33.00	5.00	3.44
2.00	20.00	54.00	5.00	5.43
3.00	27.00	66.00	5.00	7.02
4.00	30.00	73.00	5.00	7.79
5.00	33.00	77.00	5.00	8.42
6.00	35.00	80.00	5.00	8.85
7.00	36.00	81.00	5.00	9.05
8.00	40.00	81.00	5.00	9.45
9.00	41.00	81.00	5.00	9.80
10.00	41.00	81.00	5.00	9.80
11.00	45.00	81.00	5.00	10.40
12.00	45.00	81.00	5.00	10.40

DENSITY OF THE LAND USE UNITS PER GRID CELL = 1.00 (18)
 BASE VALUE OF THE STRUCTURE = 25000.00 (19)
 BASE VALUE OF THE CONTENTS = 7500.00 (20)
 BASE VALUE OF OTHER = -0. (21)
 VACANCY FACTOR (PERCENT DEVELOPED) = 60.0 (22)

ONLY NEW DEVELOPMENT IN THIS LAND USE WILL BE FLOOD PROTECTED TO A SPECIFIED PROTECTION LEVEL
 ONLY NEW DEVELOPMENT WITH THIS LAND USE WILL BE RAISED TO THE GROUND FLOOD IS ABOVE A SPECIFIED LEVEL
 ALL GRID CELLS WITH NEW DEVELOPMENT AND THIS LAND USE WHICH HAVE THEIR GROUND FLOOR IN THE RESTRICTED FLOOD PLAIN WILL BE EVACUATED AND THE DAMAGE WILL BE AGGREGATED INTO LAND USE 1

OUTPUT DISPLAY
DAMAGE-STAGE DAMAGE CALCULATION
DECEMBER 1976

DAMAGE REACH INDEX LOCATION SUMMARY

(23) ID. NO.	(24) REFERENCE FLOOD ELEVATION	(25) POLICY FLOOD ELEVATION	(26) FLOOD PROOFING ELEVATION	(27) EVACUATION ELEVATION	(28) STARTING DAMAGE ELEVATION	(29) DAMAGE ELEVATION INCHMENT	(30) AGGREGATED DAMAGE NCM, IO.	(31) MODIFY LAND USE DENSITY
1.	634.0	627.1	627.1	624.0	610.0	1.00	0	0
3.	714.0	711.9	711.9	710.8	695.0	1.00	0	0

SINGLE EVENTS FOR DAMAGE REACHES

DAMAGE REACH NO.	2 YEAR EVENT	10 YEAR EVENT	20 YEAR EVENT	50 YEAR EVENT	100 YEAR EVENT	(32) Titles of flood events	(33) Water surface elevations at the index locations for the flood events
1.	616.7	623.5	624.0	625.4	627.1		
3.	709.6	710.2	710.8	711.5	711.9		

DAMAGE REACH 1 IS BEING TRACED FOR LAND USE

(34) Trace printout as specified on JB card

* INDICATES ELEVATION IS AT GRID CELL

ROW	COL	INDEX	ALT.	LU.	REF.	*POLICY	*ELEV.	*TOPC	*TOPC	FLOOD	*ELEV.	DAMAGE	DAMAGE	DAMAGE	ACCUR.
80	7	16	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	-2.10	623.00	0.	0.
80	7	17	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	-1.10	623.00	0.	0.
80	7	18	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	-1.10	627.00	0.	0.
80	7	19	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	0.00	628.00	5.31	5.31
80	7	20	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	1.00	629.00	6.72	6.72
80	7	21	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	2.00	630.00	11.34	11.34
80	7	22	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	3.00	631.00	14.55	14.55
80	7	23	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	4.00	632.00	13.71	13.71
80	7	24	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	5.00	633.00	14.49	14.49
80	7	25	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	6.00	634.00	14.89	14.89
80	7	26	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	7.00	635.00	15.68	15.68
80	7	27	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	8.00	636.00	16.17	16.17
80	7	28	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	9.00	637.00	16.29	16.29
80	7	29	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	10.00	638.00	17.30	17.30
80	7	30	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	11.00	639.00	17.42	17.42
80	7	31	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	12.00	640.00	17.67	17.67
80	8	22	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	-3.00	631.00	0.	0.
80	8	23	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	-2.00	632.00	.28	13.99
80	8	24	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	-1.00	633.00	.58	13.03
80	8	25	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	0.	634.00	2.49	17.58
80	8	26	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	1.00	635.00	5.60	21.24
80	8	27	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	2.00	636.00	9.07	25.24
80	8	28	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	3.00	637.00	11.39	27.68
80	8	29	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	4.00	638.00	12.66	29.94
80	8	30	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	5.00	639.00	13.83	31.25
80	8	31	2	4	620.00	613.10	600.00	613.10	613.10	627.10	610.00	6.00	640.00	14.36	32.23

DAMAGE REACH 1 HAS 9. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS
DAMAGE REACH 3 HAS 1. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS

(37) Grid cells affected by nonstructural options

DAMAGE REACH 1 HAS 16. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVELS
DAMAGE REACH 3 HAS 4. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVELS

DAMAGE REACH 3 HAS 12. CELLS WITH DAMAGES STARTING BELOW THE STARTING AGGREGATION ELEVATION

DAMAGE REACH 1 HAS 160. CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION
DAMAGE REACH 3 HAS 137. CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION

(38) Grid cells above or below minimum and maximum specified aggregating elevations

OUTPUT DISPLAY
DAMCAL-STAGE DAMAGE CALCULATION
DECEMBER 1978

DAMAGE REACH NO. 1

DAMAGE REACH NO. 1

(39) Damage reach identification and title

LAND USE CATEGORIES											(40) Table of aggregated damages										
WATER SURFACE ELEVATION	1	2	3	4	5	6	7	8	9	10	TOTAL										
610.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
611.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
612.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
613.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
614.0	.15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.15
615.0	.15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.20
616.0	.15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.25
617.0	.20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.32
618.0	.25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.40
619.0	.25	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.45
620.0	.35	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.60
621.0	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.67
622.0	.45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.74
623.0	.45	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.76
624.0	.55	.30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.16
625.0	.55	.30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.24
626.0	.55	.30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.26
627.0	.70	.30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.43
627.1	.70	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.53
628.0	.80	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.53
629.0	.90	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	535.44
630.0	1.10	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	770.36
631.0	1.15	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	941.36
632.0	1.15	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1101.35
																					1201.40

(continuation of preceding page)

633.0	1.25	.40	0.	15.05	0.	0.	1310.03	58.62	.64	0.	1385.99
634.0	1.80	1.00	0.	17.38	0.	0.	1405.55	71.68	.71	0.	1498.32
635.0	1.80	1.00	0.	21.28	0.	0.	1580.62	216.32	.89	0.	1821.92
636.0	1.80	1.00	0.	25.24	0.	0.	1693.58	335.36	.95	0.	2057.94
637.0	1.80	1.00	0.	27.88	0.	0.	1790.05	426.28	1.04	0.	2248.01
638.0	1.80	1.00	0.	29.96	0.	0.	1828.05	472.32	1.13	0.	2434.25
639.0	1.85	1.00	0.	31.25	0.	0.	1993.30	509.13	1.21	0.	2537.74
640.0	1.90	1.00	0.	32.23	0.	0.	2007.46	541.25	1.28	0.	2585.12
616.7	.20	0.	0.	0.	0.	0.	0.	0.	.12	0.	.32
(2 YEAR)											
623.5	.45	.10	0.	0.	0.	0.	0.	0.	.32	0.	.87
(10 YEAR)											
628.0	.55	.30	0.	0.	0.	0.	0.	0.	.33	0.	1.18
(20 YEAR)											
625.6	.55	.30	0.	0.	0.	0.	0.	0.	.40	0.	1.25
(50 YEAR)											
627.1	.70	.40	0.	0.	0.	0.	0.	0.	.43	0.	1.53
(100 YEAR)											

DAMAGE CATEGORY -----		LAND USE CODE -----		LAND USE -----		(41) Table of damage-land use codes ----->	
1		1		NATURAL VEGETATION			
2		2		DEVELOPED OPEN SPACE			
3		3		LOW DENSITY HOUSING			
4		4		MEDIUM DENSITY HOUSING			
5		5		HIGH DENSITY HOUSING			
6		6		AGRICULTURE			
7		7		INDUSTRIAL			
8		8		COMMERCIAL			
9		9		PASTURE			
10		10		WATER BODIES			

EXHIBIT 4-2

SAMPLE PROBLEM

**ECONOMIC EFFECT OF SINGLE FLOOD EVENTS
ON THE 1990 LAND USE PLAN**

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD EVENTS
ON THE 1990 LAND USE PLAN

Problem Statement

Determine the economic impact of five single flood events (2-year, 10-year, 20-year, 50-year and 100-year events) on the projected 1990 land use pattern, and request trace output for the medium density residential land use category in damage reach 1.

The format of the data file in the Trail Creek DATA BANK is (12F4.0, 2F8.2, 2F4.0, 2F2.0) and a listing of the pertinent items of the data base file is given in Table 1.

Description of Input Requirements

The title and particular job cards are required. The key input variables for this computation are ITYPE (J1.8), to identify the number of single flood events, NODR (J3.2), for indicating the number of damage reaches in the analysis, and ILAND (J3.4), to designate the land use pattern under investigation. It should be noted that the alphanumeric characters within the parenthesis following the variable name refer to particular cards and related card columns. As an example, the first two alphanumeric characters of (J1.8) indicate the J1-card and the character(s) following the decimal point indicates a particular field (or card column group). The J8 card is used to define the damage reach and land use category for trace output. The titles of the single flood events are input on the ST card, and the water surface elevations (WSE) at the index locations for each single flood event are recorded on the SE cards.

The completed coding sheets have been included in this sample problem.

Discussion of Results

The stage-damage functions for each land use category indicated in Table 1 are displayed, one per page. The input index location data (DR card values) for the two damage reaches analyzed are also shown (page 21 of 26) along with the single flood event water surface elevations (SE card values).

The trace information (page 22 of 26) indicates that only two grid cells identified with land use 4 and in damage reach 1 are included in the aggregation of damages for this reach with regard to the 1990 land use pattern. (It should be noted that the grid cells differ in topographic elevation by 20 feet). The accumulated damage (last column) for the second grid cell displayed reflects the combined aggregated damage for both grid cells (at the index location) at the elevations shown.

As shown by the printed information at the bottom of page 22, a total of 309 grid cells in the two damage reaches analyzed (damage reaches 1 and 3) fall outside the aggregated elevation damage function ranges specified on the DR cards. There are 12 cells with damages below the starting aggregation damage elevation and 297 cells with damages starting above the maximum elevation specified.

Aggregated elevation-damage values are tabulated for damage reaches 1 and 3 on pages 23, 24, 25, and 26 for each land use category within the 1990 land use pattern. (Note that the damages in land use category 4, pages 23 and 24, correspond to the accumulated damages displayed for the trace output, page 21).

TABLE 1
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1	1	GRID CELL ROW
	Row 1	
	2-92	Rows 2-92
2	1	GRID CELL COLUMN
	Column 1	
	2-129	Columns 2-129
3	1	WATERSHED
		Trail Creek
5	1	DAMAGE REACH
	Damage reach 1	
	2-5	Damage reaches 2-5
10	1	EXISTING LAND USE
	2	Natural vegetation
	3	Developed open space
	4	Low density residential
	5	Medium density residential
	6	High density residential
	7	Agricultural
	8	Industrial
	9	Commercial
	10	Pasture
11	1	Water bodies
	2	1990 ALTERNATIVE LAND USE PATTERN
	3	Natural vegetation
	4	Developed open space
	5	Low density residential
	6	Medium density residential
	7	High density residential
	8	Agricultural
	9	Industrial
	10	Commercial
		Pasture
		Water bodies

TABLE 1 (continued)
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
13		REFERENCE FLOOD ELEVATION Flood elevations to the nearest .1 foot are stored for each grid cell in the flood plain
14		TOPOGRAPHIC ELEVATION Land elevations to the nearest .1 foot are stored for each grid cell in the study area

[illegible]

GENERAL PURPOSE DATA FORM
(6 COLUMN FIELD)

FORM NO. 1040-101		EXHIBIT 4-2		DATE		1977	
PROJECT NO. 2		Squad		PAGE		1	
1	2	3	4	5	6	7	8
MEDIUM DENSITY MAGNETIC							
LT	1	2	3	4	5	6	7
DE	2.01	2	1	1	1	1	1
DE	1.7	1.8	1.9	2.0	2.1	2.2	2.3
DE	2.4	2.5	2.6	2.7	2.8	2.9	3.0
DE	3.1	3.2	3.3	3.4	3.5	3.6	3.7
DE	3.8	3.9	4.0	4.1	4.2	4.3	4.4
DE	4.5	4.6	4.7	4.8	4.9	5.0	5.1
DE	5.2	5.3	5.4	5.5	5.6	5.7	5.8
DE	5.9	6.0	6.1	6.2	6.3	6.4	6.5
DE	6.6	6.7	6.8	6.9	7.0	7.1	7.2
DE	7.3	7.4	7.5	7.6	7.7	7.8	7.9
DE	8.0	8.1	8.2	8.3	8.4	8.5	8.6
DE	8.7	8.8	8.9	9.0	9.1	9.2	9.3
DE	9.4	9.5	9.6	9.7	9.8	9.9	10.0
DE	10.1	10.2	10.3	10.4	10.5	10.6	10.7
DE	10.8	10.9	11.0	11.1	11.2	11.3	11.4
DE	11.5	11.6	11.7	11.8	11.9	12.0	12.1
DE	12.2	12.3	12.4	12.5	12.6	12.7	12.8
DE	12.9	13.0	13.1	13.2	13.3	13.4	13.5
DE	13.6	13.7	13.8	13.9	14.0	14.1	14.2
DE	14.3	14.4	14.5	14.6	14.7	14.8	14.9
DE	15.0	15.1	15.2	15.3	15.4	15.5	15.6
DE	15.7	15.8	15.9	16.0	16.1	16.2	16.3
DE	16.4	16.5	16.6	16.7	16.8	16.9	17.0
DE	17.1	17.2	17.3	17.4	17.5	17.6	17.7
DE	17.8	17.9	18.0	18.1	18.2	18.3	18.4
DE	18.5	18.6	18.7	18.8	18.9	19.0	19.1
DE	19.2	19.3	19.4	19.5	19.6	19.7	19.8
DE	19.9	20.0	20.1	20.2	20.3	20.4	20.5
DE	20.6	20.7	20.8	20.9	21.0	21.1	21.2
DE	21.3	21.4	21.5	21.6	21.7	21.8	21.9
DE	22.0	22.1	22.2	22.3	22.4	22.5	22.6
DE	22.7	22.8	22.9	23.0	23.1	23.2	23.3
DE	23.4	23.5	23.6	23.7	23.8	23.9	24.0
DE	24.1	24.2	24.3	24.4	24.5	24.6	24.7
DE	24.8	24.9	25.0	25.1	25.2	25.3	25.4
DE	25.5	25.6	25.7	25.8	25.9	26.0	26.1
DE	26.2	26.3	26.4	26.5	26.6	26.7	26.8
DE	26.9	27.0	27.1	27.2	27.3	27.4	27.5
DE	27.6	27.7	27.8	27.9	28.0	28.1	28.2
DE	28.3	28.4	28.5	28.6	28.7	28.8	28.9
DE	29.0	29.1	29.2	29.3	29.4	29.5	29.6
DE	29.7	29.8	29.9	30.0	30.1	30.2	30.3
DE	30.4	30.5	30.6	30.7	30.8	30.9	31.0
DE	31.1	31.2	31.3	31.4	31.5	31.6	31.7
DE	31.8	31.9	32.0	32.1	32.2	32.3	32.4
DE	32.5	32.6	32.7	32.8	32.9	33.0	33.1
DE	33.2	33.3	33.4	33.5	33.6	33.7	33.8
DE	33.9	34.0	34.1	34.2	34.3	34.4	34.5
DE	34.6	34.7	34.8	34.9	35.0	35.1	35.2
DE	35.3	35.4	35.5	35.6	35.7	35.8	35.9
DE	36.0	36.1	36.2	36.3	36.4	36.5	36.6
DE	36.7	36.8	36.9	37.0	37.1	37.2	37.3
DE	37.4	37.5	37.6	37.7	37.8	37.9	38.0
DE	38.1	38.2	38.3	38.4	38.5	38.6	38.7
DE	38.8	38.9	39.0	39.1	39.2	39.3	39.4
DE	39.5	39.6	39.7	39.8	39.9	40.0	40.1
DE	40.2	40.3	40.4	40.5	40.6	40.7	40.8
DE	40.9	41.0	41.1	41.2	41.3	41.4	41.5
DE	41.6	41.7	41.8	41.9	42.0	42.1	42.2
DE	42.3	42.4	42.5	42.6	42.7	42.8	42.9
DE	43.0	43.1	43.2	43.3	43.4	43.5	43.6
DE	43.7	43.8	43.9	44.0	44.1	44.2	44.3
DE	44.4	44.5	44.6	44.7	44.8	44.9	45.0
DE	45.1	45.2	45.3	45.4	45.5	45.6	45.7
DE	45.8	45.9	46.0	46.1	46.2	46.3	46.4
DE	46.5	46.6	46.7	46.8	46.9	47.0	47.1
DE	47.2	47.3	47.4	47.5	47.6	47.7	47.8
DE	47.9	48.0	48.1	48.2	48.3	48.4	48.5
DE	48.6	48.7	48.8	48.9	49.0	49.1	49.2
DE	49.3	49.4	49.5	49.6	49.7	49.8	49.9
DE	50.0	50.1	50.2	50.3	50.4	50.5	50.6
DE	50.7	50.8	50.9	51.0	51.1	51.2	51.3
DE	51.4	51.5	51.6	51.7	51.8	51.9	52.0
DE	52.1	52.2	52.3	52.4	52.5	52.6	52.7
DE	52.8	52.9	53.0	53.1	53.2	53.3	53.4
DE	53.5	53.6	53.7	53.8	53.9	54.0	54.1
DE	54.2	54.3	54.4	54.5	54.6	54.7	54.8
DE	54.9	55.0	55.1	55.2	55.3	55.4	55.5
DE	55.6	55.7	55.8	55.9	56.0	56.1	56.2
DE	56.3	56.4	56.5	56.6	56.7	56.8	56.9
DE	57.0	57.1	57.2	57.3	57.4	57.5	57.6
DE	57.7	57.8	57.9	58.0	58.1	58.2	58.3
DE	58.4	58.5	58.6	58.7	58.8	58.9	59.0
DE	59.1	59.2	59.3	59.4	59.5	59.6	59.7
DE	59.8	59.9	60.0	60.1	60.2	60.3	60.4
DE	60.5	60.6	60.7	60.8	60.9	61.0	61.1
DE	61.2	61.3	61.4	61.5	61.6	61.7	61.8
DE	61.9	62.0	62.1	62.2	62.3	62.4	62.5
DE	62.6	62.7	62.8	62.9	63.0	63.1	63.2
DE	63.3	63.4	63.5	63.6	63.7	63.8	63.9
DE	64.0	64.1	64.2	64.3	64.4	64.5	64.6
DE	64.7	64.8	64.9	65.0	65.1	65.2	65.3
DE	65.4	65.5	65.6	65.7	65.8	65.9	66.0
DE	66.1	66.2	66.3	66.4	66.5	66.6	66.7
DE	66.8	66.9	67.0	67.1	67.2	67.3	67.4
DE	67.5	67.6	67.7	67.8	67.9	68.0	68.1
DE	68.2	68.3	68.4	68.5	68.6	68.7	68.8
DE	68.9	69.0	69.1	69.2	69.3	69.4	69.5
DE	69.6	69.7	69.8	69.9	70.0	70.1	70.2
DE	70.3	70.4	70.5	70.6	70.7	70.8	70.9
DE	71.0	71.1	71.2	71.3	71.4	71.5	71.6
DE	71.7	71.8	71.9	72.0	72.1	72.2	72.3
DE	72.4	72.5	72.6	72.7	72.8	72.9	73.0
DE	73.1	73.2	73.3	73.4	73.5	73.6	73.7
DE	73.8	73.9	74.0	74.1	74.2	74.3	74.4
DE	74.5	74.6	74.7	74.8	74.9	75.0	75.1
DE	75.2	75.3	75.4	75.5	75.6	75.7	75.8
DE	75.9	76.0	76.1	76.2	76.3	76.4	76.5
DE	76.6	76.7	76.8	76.9	77.0	77.1	77.2
DE	77.3	77.4	77.5	77.6	77.7	77.8	77.9
DE	78.0	78.1	78.2	78.3	78.4	78.5	78.6
DE	78.7	78.8	78.9	79.0	79.1	79.2	79.3
DE	79.4	79.5	79.6	79.7	79.8	79.9	80.0
DE	80.1	80.2	80.3	80.4	80.5	80.6	80.7
DE	80.8	80.9	81.0	81.1	81.2	81.3	81.4
DE	81.5	81.6	81.7	81.8	81.9	82.0	82.1
DE	82.2	82.3	82.4	82.5	82.6	82.7	82.8
DE	82.9	83.0	83.1	83.2	83.3	83.4	83.5
DE	83.6	83.7	83.8	83.9	84.0	84.1	84.2
DE	84.3	84.4	84.5	84.6	84.7	84.8	84.9
DE	85.0	85.1	85.2	85.3	85.4	85.5	85.6
DE	85.7	85.8	85.9	86.0	86.1	86.2	86.3
DE	86.4	86.5	86.6	86.7	86.8	86.9	87.0
DE	87.1	87.2	87.3	87.4	87.5	87.6	87.7
DE	87.8	87.9	88.0	88.1	88.2	88.3	88.4
DE	88.5	88.6	88.7	88.8	88.9	89.0	89.1
DE	89.2	89.3	89.4	89.5	89.6	89.7	89.8
DE	89.9	90.0	90.1	90.2	90.3	90.4	90.5
DE	90.6	90.7	90.8	90.9	91.0	91.1	91.2
DE	91.3	91.4	91.5	91.6	91.7	91.8	91.9
DE	92.0	92.1	92.2	92.3	92.4	92.5	92.6
DE	92.7	92.8	92.9	93.0	93.1	93.2	93.3
DE	93.4	93.5	93.6	93.7	93.8	93.9	94.0
DE	94.1	94.2	94.3	94.4	94.5	94.6	94.7
DE	94.8	94.9	95.0	95.1	95.2	95.3	95.4
DE	95.5	95.6	95.7	95.8	95.9	96.0	96.1
DE	96.2	96.3	96.4	96.5	96.6	96.7	96.8
DE	96.9	97.0	97.1	97.2	97.3	97.4	97.5
DE	97.6	97.7	97.8	97.9	98.0	98.1	98.2
DE	98.3	98.4	98.5	98.6	98.7	98.8	98.9
DE	99.0	99.1	99.2	99.3	99.4	99.5	99.6
DE	99.7	99.8	99.9	100.0	100.1	100.2	100.3
DE	100.4	100.5	100.6	100.7	100.8	100.9	101.0
DE	101.1	101.2	101.3	101.4	101.5	101.6	101.7

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELD)

PROGRAM		EXHIBIT		7-2		DATE		1879	
REQUESTED BY		O. Goodrich		PREPARED BY		COLLECTED BY		DATE	
1	2	3	4	5	6	7	8	9	10
25	0	30.5	30	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0
95	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0

[illegible]

J2 CARD

	j2	1	i	18	92	124	0
CC	123M567800123456789012345678901234567890123456789012345678901234567890						

```
DATA BANK INFORMATION
=====
NFILE = 1, THE DATA BANK IS ON THIS COMPUTER UNIT
NFORM = 1, THE DATA BANK IS FORMATTED
NDV = 18, THE NUMBER OF DATA VARIABLES
IRO = 92, THE NUMBER OF ROWS IN THE DATA BANK
ICOL = 128, THE NUMBER OF COLUMNS IN THE DATA BANK
IMAGE = 0, NO PRINTED IMAGE OF INPUT DECK
```

J3 CARD

 CC 123456789012345678901234567890123456789012345678901234567890
 J3 5 2 11 10 10 10 10 13 31
 DATA VARIABLE INFORMATION

 ID4MC = 5, THE DATA VARIABLE THAT IS THE DAMAGE REACH CODE
 NDCR = 2, THE NUMBER OF DAMAGE REACHES IN THIS ANALYSIS
 ILAND = 11, THE DATA VARIABLE THAT IS THE LAND USE ANALYZED
 IBASE = 10, THE DATA VARIABLE CONSIDERED THE BASE CONDUITION
 NOLUC = 10, THE NUMBER OF LAND USE CATEGORIES
 ITOPG = 14, THE DATA VARIABLE THAT IS TOPOGRAPHY
 TRFPO = 13, THE DATA VARIABLE THAT IS THE REFERENCE FLOOD ELEVATION
 IELV = 31, THE NUMBER OF ELEVATION-DAMAGE POINTS TO BE CALCULATED

J8 CARD

 CC 123456789012345678901234567890123456789012345678901234567890
 J8 1 4
 TRACE INFORMATION

 MDCR = 1, TRACE OUTPUT PROVIDED IN THIS DAMAGE REACH
 NMLU = 4, TRACE OUTPUT PROVIDED FOR THIS LAND USE CATEGORY

FORMAT CARD

 CC 123456789012345678901234567890123456789012345678901234567890
 /T(12Pa,0.2Pa,0.2Pa,0)

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN

LAND USE CATEGORY NO. 1

NATURAL VEGETATION

DEPTH	PERCENT	PERCENT	PERCENT	AMOUNT OF DAMAGE
OF	DAMAGE	DAMAGE	DAMAGE	PER GRID CELL
WATER	STRUCTURE	CONTENTS	OTHER	IN THOUSAND DOLLARS
0.01	0.	0.	0.	0.
0.	0.	0.	0.	.05
10.00	0.	0.	0.	.05

DENSITY OF THE LAND USE UNITS PER GRID CELL = 1.00

BASE VALUE OF THE STRUCTURE = 0.

BASE VALUE OF THE CONTENTS = 0.

BASE VALUE OF OTHER = 0.

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

NOTE: DAMAGES ARE INPUT DIRECTLY
IF DAMAGES ARE TO BE ADJUSTED FOR THIS LAND USE CATEGORY BY DAMAGE REACH
THEN DENSITY, VACANCY, AND BASE VALUES MUST BE INPUT

EXHIBIT 4-2
JANUARY 1979

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN

LAND USE CATEGORY NO. 2

DEVELOPED OPEN SPACE

DEPTH	PERCENT	PERCENT	PERCENT	PERCENT	AMOUNT OF DAMAGE
OF	DAMAGE	DAMAGE	DAMAGE	DAMAGE	PER GRID CELL
WATER	STRUCTURE	CONTENTS	OTHER	IN THOUSAND DOLLARS	
0.01	0.	0.	0.	0.	0.
0.	0.	0.	100.00		.10
10.00	0.	0.	100.00		.10

DENSITY OF THE LAND USE UNITS PER GRID CELL = 1.00

BASE VALUE OF THE STRUCTURE = 0.

BASE VALUE OF THE CONTENTS = 0.

BASE VALUE OF OTHER = 100.00

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

SAMPLE PRIMER
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN

LAND USE CATEGORY NO. 3

LOW DENSITY HOUSING

DEPTH OF WATER	PERCENT OF DAMAGE	PERCENT OF CONTENTS	PERCENT OF DAMAGE	PERCENT OF CONTENTS	AMOUNT OF DAMAGE	AMOUNT OF CONTENTS
0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00
2.00	2.00	2.00	2.00	2.00	2.00	2.00
3.00	3.00	3.00	3.00	3.00	3.00	3.00
4.00	4.00	4.00	4.00	4.00	4.00	4.00
5.00	5.00	5.00	5.00	5.00	5.00	5.00
6.00	6.00	6.00	6.00	6.00	6.00	6.00
7.00	7.00	7.00	7.00	7.00	7.00	7.00
8.00	8.00	8.00	8.00	8.00	8.00	8.00
9.00	9.00	9.00	9.00	9.00	9.00	9.00
10.00	10.00	10.00	10.00	10.00	10.00	10.00
11.00	11.00	11.00	11.00	11.00	11.00	11.00
12.00	12.00	12.00	12.00	12.00	12.00	12.00
13.00	13.00	13.00	13.00	13.00	13.00	13.00
14.00	14.00	14.00	14.00	14.00	14.00	14.00
15.00	15.00	15.00	15.00	15.00	15.00	15.00
16.00	16.00	16.00	16.00	16.00	16.00	16.00
17.00	17.00	17.00	17.00	17.00	17.00	17.00
18.00	18.00	18.00	18.00	18.00	18.00	18.00
19.00	19.00	19.00	19.00	19.00	19.00	19.00
20.00	20.00	20.00	20.00	20.00	20.00	20.00
21.00	21.00	21.00	21.00	21.00	21.00	21.00
22.00	22.00	22.00	22.00	22.00	22.00	22.00
23.00	23.00	23.00	23.00	23.00	23.00	23.00
24.00	24.00	24.00	24.00	24.00	24.00	24.00
25.00	25.00	25.00	25.00	25.00	25.00	25.00
26.00	26.00	26.00	26.00	26.00	26.00	26.00
27.00	27.00	27.00	27.00	27.00	27.00	27.00
28.00	28.00	28.00	28.00	28.00	28.00	28.00
29.00	29.00	29.00	29.00	29.00	29.00	29.00
30.00	30.00	30.00	30.00	30.00	30.00	30.00
31.00	31.00	31.00	31.00	31.00	31.00	31.00
32.00	32.00	32.00	32.00	32.00	32.00	32.00
33.00	33.00	33.00	33.00	33.00	33.00	33.00
34.00	34.00	34.00	34.00	34.00	34.00	34.00
35.00	35.00	35.00	35.00	35.00	35.00	35.00
36.00	36.00	36.00	36.00	36.00	36.00	36.00
37.00	37.00	37.00	37.00	37.00	37.00	37.00
38.00	38.00	38.00	38.00	38.00	38.00	38.00
39.00	39.00	39.00	39.00	39.00	39.00	39.00
40.00	40.00	40.00	40.00	40.00	40.00	40.00
41.00	41.00	41.00	41.00	41.00	41.00	41.00
42.00	42.00	42.00	42.00	42.00	42.00	42.00
43.00	43.00	43.00	43.00	43.00	43.00	43.00
44.00	44.00	44.00	44.00	44.00	44.00	44.00
45.00	45.00	45.00	45.00	45.00	45.00	45.00
46.00	46.00	46.00	46.00	46.00	46.00	46.00
47.00	47.00	47.00	47.00	47.00	47.00	47.00
48.00	48.00	48.00	48.00	48.00	48.00	48.00
49.00	49.00	49.00	49.00	49.00	49.00	49.00
50.00	50.00	50.00	50.00	50.00	50.00	50.00
51.00	51.00	51.00	51.00	51.00	51.00	51.00
52.00	52.00	52.00	52.00	52.00	52.00	52.00
53.00	53.00	53.00	53.00	53.00	53.00	53.00
54.00	54.00	54.00	54.00	54.00	54.00	54.00
55.00	55.00	55.00	55.00	55.00	55.00	55.00
56.00	56.00	56.00	56.00	56.00	56.00	56.00
57.00	57.00	57.00	57.00	57.00	57.00	57.00
58.00	58.00	58.00	58.00	58.00	58.00	58.00
59.00	59.00	59.00	59.00	59.00	59.00	59.00
60.00	60.00	60.00	60.00	60.00	60.00	60.00

DENSITY OF THE LAND USE LIMITS PER GRID CELL = 1.00

BASE VALUE OF THE STRUCTURE = 25000.00

BASE VALUE OF THE CONTENTS = 7500.00

BASE VALUE OF OTHER = -0.00

VACANCY FACTOR (PERCENT DEVELOPED) = 60.00

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1966 LAND USE PLAN

LAND USE CATEGORY NO. 4

MEDIUM DENSITY HOUSING

DEPTH OF WATER	PERCENT DAMAGE TO STRUCTURE	PERCENT DAMAGE TO CONTENTS	PERCENT DAMAGE TO OTHER	AMOUNT OF DAMAGE PER GRID CELL IN THOUSAND DOLLARS
-2.01	0.	0.	0.	0.
-2.00	1.00	0.	5.00	.28
-1.00	2.00	0.	5.00	.56
0.	9.00	2.00	5.00	2.69
1.00	11.00	30.00	5.00	5.60
2.00	14.00	48.00	5.00	9.07
3.00	24.00	54.00	5.00	11.39
4.00	26.00	64.00	5.00	12.66
5.00	29.00	68.00	5.00	13.83
6.00	31.00	70.00	4.00	14.56
7.00	32.00	71.00	4.00	14.92
8.00	35.00	71.00	4.00	15.76
9.00	36.00	73.00	4.00	16.21
10.00	38.00	74.00	4.00	16.30
11.00	40.00	74.00	3.00	17.42
12.00	40.00	74.00	3.00	17.42
13.00	41.00	74.00	3.00	17.70
14.00	42.00	74.00	3.00	17.98
15.00	43.00	74.00	3.00	18.26
16.00	44.00	74.00	2.00	18.54
17.00	45.00	74.00	2.00	18.82
18.00	45.00	74.00	2.00	18.82
19.00	45.00	74.00	2.00	18.82
20.00	45.00	74.00	2.00	18.82

DENSITY OF THE LAND USE UNITS PER GRID CELL = 4.00

BASE VALUE OF THE STRUCTURE = 10000.00

BASE VALUE OF THE CONTENTS (30.00 PERCENT OF THE STRUCTURE VALUE) = 3000.00

BASE VALUE OF OTHER = 0.

VACANCY FACTOR (PERCENT DEVELOPED) = 70.0

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN

LAND USE CATEGORY NO. 5

HIGH DENSITY HOUSING

DEPTH OF WATER	PERCENT OF STRUCTURES	PERCENT OF CONTENTS	PERCENT OF DAMAGE	PERCENT OF DAMAGE PER GRID CELL	AMOUNT OF DAMAGE PER GRID CELL
-5.01	0.	0.	0.	0.	0.
-5.00	2.00	2.00	5.00	5.00	15.60
-4.00	2.00	2.00	5.00	5.00	15.60
-3.00	2.00	3.00	5.00	5.00	17.40
-2.00	2.00	3.00	5.00	5.00	17.40
-1.00	2.00	3.00	5.00	5.00	17.40
0.	2.00	3.00	5.00	5.00	17.40
1.00	9.00	25.00	5.00	5.00	99.00
2.00	13.00	37.00	5.00	5.00	144.60
3.00	17.00	44.00	5.00	5.00	181.20
4.00	20.00	46.00	5.00	5.00	202.80
5.00	21.00	47.00	5.00	5.00	210.60
6.00	23.00	48.00	5.00	5.00	224.40
7.00	24.00	48.00	5.00	5.00	230.40
8.00	26.00	48.00	5.00	5.00	242.40
9.00	33.00	52.00	5.00	5.00	291.60
10.00	37.00	62.00	5.00	5.00	333.60
11.00	41.00	67.00	5.00	5.00	366.60
12.00	43.00	71.00	5.00	5.00	385.80
13.00	45.00	74.00	5.00	5.00	403.20
14.00	46.00	75.00	5.00	5.00	411.00
15.00	48.00	75.00	5.00	5.00	423.00
16.00	50.00	75.00	5.00	5.00	435.00
17.00	50.00	75.00	5.00	5.00	435.00

DENSITY OF THE LAND USE UNITS PER GRID CELL = 12.00

BASE VALUE OF THE STRUCTURE = 50000.00

BASE VALUE OF THE CONTENTS (30.00 PERCENT OF THE STRUCTURE VALUE) = 15000.00

BASE VALUE OF UTILITIES = 0.

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

SAMPLE PROBLEM

LAND USE CATEGORY NO. 6

AGRICULTURE

DEPTH OF WATER	PERCENT OF STRUCTURE CONTENTS	PERCENT DAMAGE	PERCENT DAMAGE OTHER	AMOUNT OF DAMAGE PER GIRD CELL IN THOUSAND DOLLARS
0.	0.	0.	0.	0.
1.00	30.50	0.	5.00	.04
2.00	40.00	0.	5.00	.05
3.00	48.00	0.	5.00	.06
4.00	54.50	0.	5.00	.07
5.00	61.50	0.	5.00	.07
6.00	68.50	0.	5.00	.08
7.00	68.50	0.	5.00	.08
8.00	68.50	0.	5.00	.08
9.00	68.50	0.	5.00	.04

DENSITY OF THE LAND USE UNITS PER GRID CELL = 1.00

PHASE VALUE OF THE STRUCTURE \$ 120.00

BASE VALUE OF THE CONTENTS = 0.

BASE VALUE OF OTHER = 0.

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN

LAND USE CATEGORY NO. 7

INDUSTRIAL

DEPTH OF WATER	PERCENT DAMAGE STRUCTURE	PERCENT DAMAGE CONTENTS	PERCENT DAMAGE OTHER	AMOUNT OF DAMAGE PER GRID CELL IN THOUSAND DOLLARS
-2.01	0.	0.	0.	0.
-2.00	1.00	0.	0.	1.18
-1.00	1.00	0.	0.	1.18
0.	7.00	5.00	5.00	19.61
1.00	12.00	28.00	15.00	71.22
2.00	18.00	37.00	20.00	96.73
3.00	24.00	43.00	22.00	115.43
4.00	27.00	49.00	30.00	133.99
5.00	29.00	55.00	45.00	154.07
6.00	31.00	59.00	50.00	166.01
7.00	32.00	63.00	55.00	176.77
8.00	35.00	67.00	80.00	199.89
9.00	38.00	71.00	85.00	213.01
10.00	40.00	75.00	90.00	224.93
11.00	44.00	81.00	95.00	242.79
12.00	44.00	85.00	95.00	249.87
13.00	45.00	85.00	95.00	251.05
14.00	45.00	85.00	95.00	251.05
15.00	46.00	85.00	95.00	252.23
16.00	47.00	85.00	95.00	253.41

DENSITY OF THE LAND USE UNITS PER GRID CELL = .20

BASE VALUE OF THE STRUCTURE \$390000.00

BASE VALUE OF THE CONTENTS \$85000.00

BASE VALUE OF OTHER \$250000.00

VACANCY FACTOR (PERCENT DEVELOPED) \$100.0

EXHIBIT 4-2
JANUARY 1979

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN
LAND USE CATEGORY NO. 8

COMMERCIAL

DEPTH OF WATER	PERCENT OF DAMAGE	PERCENT OF CONTENTS	PERCENT OF OTHER	PERCENT OF DAMAGE	PERCENT OF CONTENTS	PERCENT OF OTHER	AMOUNT OF DAMAGE PER GRID CELL	AMOUNT OF CONTENTS PER GRID CELL	AMOUNT OF OTHER PER GRID CELL
0.01	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.02	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.03	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.04	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.05	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.06	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.07	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.08	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.09	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.10	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.11	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.12	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.13	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.14	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.15	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.16	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.17	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.18	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.19	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.20	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.21	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.22	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.23	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.24	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.25	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.26	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.27	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.28	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.29	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.30	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.31	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.32	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.33	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.34	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.35	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.36	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.37	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.38	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.39	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.40	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.41	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.42	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.43	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.44	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.45	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.46	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.47	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.48	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.49	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.50	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.51	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.52	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.53	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.54	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.55	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.56	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.57	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.58	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.59	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.60	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.61	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.62	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.63	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.64	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.65	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.66	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.67	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.68	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.69	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.70	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.71	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.72	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.73	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.74	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.75	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.76	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.77	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.78	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.79	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.80	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.81	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.82	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.83	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.84	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.85	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.86	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.87	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.88	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.89	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.90	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.91	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.92	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.93	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.94	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.95	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.96	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.97	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.98	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.99	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.00	0.	0.	0.	0.	0.	0.	0.	0.	0.

DENSITY OF THE LAND USE UNITS PER GRID CELL = 4.00
 BASE VALUE OF THE STRUCTURE = 30000.00
 BASE VALUE OF THE CONTENTS (40.00 PERCENT OF THE STRUCTURE VALUE) = 30000.00
 BASE VALUE OF OTHER = -J.
 VACANCY FACTOR (PERCENT DEVELOPED) = 80.0

SIMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN

LAND USE CATEGORY NO. 9

PASTURE

DEPTH OF WATER	PERCENT OF DAMAGE TO STRUCTURES	PERCENT OF DAMAGE TO CONTENTS	PERCENT OF DAMAGE TO OTHER	AMOUNT OF DAMAGE PER GRID CELL	AMOUNT OF DAMAGE IN THOUSAND DOLLARS
0.	0.	0.	0.	0.	0.
1.00	9.00	0.	5.00		.01
2.00	10.00	0.	5.00		.01
3.00	12.00	0.	5.00		.01
4.00	14.00	0.	5.00		.02
5.00	16.00	0.	5.00		.02
6.00	18.00	0.	5.00		.02
7.00	18.00	0.	5.00		.02

DENSITY OF THE LAND USE UNITS PER GRID CELL = 1.00

BASE VALUE OF THE STRUCTURE = 120.00

BASE VALUE OF THE CONTENTS = 0.

BASE VALUE OF OTHER = -0.

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

**SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN**

LAND USE CATEGORY NO. 10

WATER DOOLIE

DEATH OF WATER	PERCENT DAMAGE STRUCTURES	PERCENT DAMAGE CONTENTS	PERCENT DAMAGE OTHER	AMOUNT OF DAMAGE PER GROSS CELL IN THOUSAND DOLLARS
0.	0.	0.	0.	0.
10.00	0.	0.	0.	0.

DENSITY OF THE LAND USE UNITS PER GRID CELL = 1.00

BASE VALUE OF THE STRUCTURE = 0.

BASE VALUE OF THE CONTENTS IS 0.

BASE VALUE OF OTHER = 0.

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

EXHIBIT 4-2
JANUARY 1979

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1980 LAND USE PLAN

DAMAGE REACH INDEX LOCATION SUMMARY

ID. NO.	REFERENCE FLOOD ELEVATION	POLICY FLOOD ELEVATION	FLOOD PROOFING ELEVATION	EVACUATION ELEVATION	STARTING DAMAGE ELEVATION	DAMAGE ELEVATION INCREMENT	AGGREGATED DAMAGE ACH. 10.	MODIFY LAND USE DENSITY
1.	634.0	0.	0.	0.	610.0	1.00	0	0
3.	714.0	0.	0.	0.	695.0	1.00	0	0

SINGLE EVENTS FOR DAMAGE REACHES

DAMAGE REACH NO.	2 YEAR EVENT	10 YEAR EVENT	20 YEAR EVENT	50 YEAR EVENT	100 YEAR EVENT
1.	616.7	623.5	624.0	625.6	627.1
3.	709.6	710.2	710.6	711.5	711.9

DAMAGE REACH 1 IS BEING TRACED FOR LAND USE 4

* INDICATES ELEVATION IS AT GRID CELL

ROW	COL	ARRAY BASE ALT. INDEX L.U. L.U.	REF. FLOOD ELEV.	POLICY ELEV.	STOMP BEFORE POLICY	STOMP AFTER POLICY	FLOOD PROOF ELEV.	EVAC. ELEV.	DAMAGE FUNC. STAGE	DAMAGE ELEV.	DAMAGE	ACCUM. DAMAGE
80	7	2	2	4	620.00	600.00	0.	0.	-3.00	611.00	0.	0.
80	7	3	2	4	620.00	600.00	0.	0.	-2.00	612.00	.28	.28
80	7	4	2	4	620.00	600.00	0.	0.	-1.00	613.00	.56	.56
80	7	5	2	4	620.00	600.00	0.	0.	0.	614.00	2.60	2.60
80	7	6	2	4	620.00	600.00	0.	0.	1.00	615.00	5.60	5.60
80	7	7	2	4	620.00	600.00	0.	0.	2.00	616.00	9.07	9.07
80	7	8	2	4	620.00	600.00	0.	0.	3.00	617.00	11.59	11.59
80	7	9	2	4	620.00	600.00	0.	0.	4.00	618.00	12.64	12.64
80	7	10	2	4	620.00	600.00	0.	0.	5.00	619.00	13.43	13.43
80	7	11	2	4	620.00	600.00	0.	0.	6.00	620.00	14.56	14.56
80	7	12	2	4	620.00	600.00	0.	0.	7.00	621.00	15.82	15.82
80	7	13	2	4	620.00	600.00	0.	0.	8.00	622.00	17.76	17.76
80	7	14	2	4	620.00	600.00	0.	0.	9.00	623.00	19.21	19.21
80	7	15	2	4	620.00	600.00	0.	0.	10.00	624.00	20.81	20.81
80	7	16	2	4	620.00	600.00	0.	0.	11.00	625.00	22.30	22.30
80	7	17	2	4	620.00	600.00	0.	0.	12.00	626.00	23.42	23.42
80	7	18	2	4	620.00	600.00	0.	0.	13.00	627.00	24.70	24.70
80	7	19	2	4	620.00	600.00	0.	0.	14.00	628.00	26.00	26.00
80	7	20	2	4	620.00	600.00	0.	0.	15.00	629.00	27.36	27.36
80	7	21	2	4	620.00	600.00	0.	0.	16.00	630.00	28.56	28.56
80	7	22	2	4	620.00	600.00	0.	0.	17.00	631.00	29.82	29.82
80	7	23	2	4	620.00	600.00	0.	0.	18.00	632.00	31.02	31.02
80	7	24	2	4	620.00	600.00	0.	0.	19.00	633.00	32.02	32.02
80	7	25	2	4	620.00	600.00	0.	0.	20.00	634.00	33.02	33.02
80	7	26	2	4	620.00	600.00	0.	0.	21.00	635.00	34.02	34.02
80	7	27	2	4	620.00	600.00	0.	0.	22.00	636.00	35.02	35.02
80	7	28	2	4	620.00	600.00	0.	0.	23.00	637.00	36.02	36.02
80	7	29	2	4	620.00	600.00	0.	0.	24.00	638.00	37.02	37.02
80	7	30	2	4	620.00	600.00	0.	0.	25.00	639.00	38.02	38.02
80	7	31	2	4	620.00	600.00	0.	0.	26.00	640.00	39.02	39.02
80	8	22	2	4	620.00	620.00	0.	0.	-2.00	631.00	.28	.28
80	8	23	2	4	620.00	620.00	0.	0.	-1.00	632.00	.56	.56
80	8	24	2	4	620.00	620.00	0.	0.	0.	633.00	2.60	2.60
80	8	25	2	4	620.00	620.00	0.	0.	1.00	634.00	5.60	5.60
80	8	26	2	4	620.00	620.00	0.	0.	2.00	635.00	9.07	9.07
80	8	27	2	4	620.00	620.00	0.	0.	3.00	636.00	11.59	11.59
80	8	28	2	4	620.00	620.00	0.	0.	4.00	637.00	12.64	12.64
80	8	29	2	4	620.00	620.00	0.	0.	5.00	638.00	13.43	13.43
80	8	30	2	4	620.00	620.00	0.	0.	6.00	639.00	14.56	14.56
80	8	31	2	4	620.00	620.00	0.	0.	7.00	640.00	15.82	15.82

DAMAGE REACH 3 HAS 12, CELLS WITH DAMAGES STARTING BELOW THE STARTING AGGREGATION ELEVATION

DAMAGE REACH 1 HAS 160, CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION
DAMAGE REACH 3 HAS 137, CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION

SAMPLE PROBLEM
 ECONOMIC EFFECT OF SINGLE FLOOD
 EVENTS ON THE 1990 LAND USE PLAN
 DAMAGE MEAS. NO. 1
 JANUARY 1979
 DAMAGE MEAS. IN-100000 TO CONFLUENCE

WATER SURFACE ELEVATION	LAND USE CATEGORIES										TOTAL
	1	2	3	4	5	6	7	8	9	10	
610.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
611.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
612.0	0.	0.	0.	.24	0.	0.	0.24	0.	0.	0.	0.50
613.0	0.	0.	0.	.56	0.	0.	0.56	0.	0.	0.	0.82
614.0	.15	0.	0.	2.84	0.	0.	137.27	0.	0.	0.	140.11
615.0	.15	0.	0.	5.80	0.	0.	498.34	0.	.07	0.	504.36
616.0	.15	0.	0.	9.07	0.	0.	676.24	0.	.10	0.	687.61
617.0	.20	0.	0.	11.59	0.	0.	822.09	0.	.12	0.	834.01
618.0	.25	0.	0.	12.86	0.	0.	990.67	0.	.15	0.	1003.62
619.0	.25	0.	0.	13.83	0.	0.	1167.37	0.	.18	0.	1181.83
620.0	.35	0.	0.	14.36	0.	0.	1271.89	0.	.23	0.	1287.05
621.0	.40	0.	0.	14.92	0.	0.	1365.33	0.	.27	0.	1381.12
622.0	.45	0.	0.	15.76	0.	0.	1567.16	0.	.29	0.	1568.66
623.0	.55	0.	0.	16.21	0.	0.	1633.30	0.	.31	0.	1670.67
624.0	.55	.30	0.	16.30	0.	0.	1748.19	0.	.33	0.	1765.67
625.0	.55	.30	0.	17.42	0.	0.	1892.46	0.	.39	0.	1911.16
626.0	.55	.30	0.	17.42	0.	0.	1958.16	0.	.41	0.	1976.86
627.0	.70	.30	0.	17.71	0.	0.	1976.72	0.	.43	0.	1997.84
628.0	.80	.40	0.	17.98	0.	0.	1994.79	0.	.46	0.	2014.43
629.0	.90	.40	0.	18.26	0.	0.	2013.36	0.	.49	0.	2036.80
630.0	1.10	.40	0.	18.34	0.	0.	2024.37	0.	.52	0.	2066.58
631.0	1.15	.40	0.	18.42	0.	0.	2024.92	0.	.55	0.	2076.35
632.0	1.15	.40	0.	19.10	0.	0.	2025.75	0.	.58	0.	2092.94

633.0	1.25	.40	0.	0.	19.38	0.	0.	2028.93	58.62	.64	0.	2107.22
634.0	1.80	1.00	0.	0.	21.50	0.	0.	2027.20	71.68	.71	0.	2123.97
635.0	1.80	1.00	0.	0.	24.42	0.	0.	2027.20	216.32	.89	0.	2271.71
636.0	1.80	1.00	0.	0.	27.89	0.	0.	2027.20	335.36	.95	0.	2394.28
637.0	1.80	1.00	0.	0.	30.41	0.	0.	2027.20	426.24	1.04	0.	2487.77
638.0	1.80	1.00	0.	0.	31.47	0.	0.	2027.20	472.32	1.13	0.	2535.00
639.0	1.85	1.00	0.	0.	32.65	0.	0.	2027.20	509.13	1.21	0.	2573.12
640.0	1.90	1.00	0.	0.	33.38	0.	0.	2027.20	541.25	1.28	0.	2606.10
616.7	.20	0.	0.	0.	10.84	0.	0.	777.29	0.	.12	0.	788.43
623.3	.45	.10	0.	0.	16.25	0.	0.	1701.02	0.	.32	0.	1718.14
624.0	.55	.30	0.	0.	16.30	0.	0.	1748.19	0.	.33	0.	1765.67
625.6	.55	.30	0.	0.	17.42	0.	0.	1933.09	0.	.40	0.	1951.76
627.1	.70	.40	0.	0.	17.72	0.	0.	1979.91	0.	.43	0.	1999.17

DAMAGE CATEGORY	LAND USE CODE	LAND USE
1	1	NATURAL VEGETATION
2	2	DEVELOPED OPEN SPACE
3	3	LOW DENSITY HOUSING
4	4	MEDIUM DENSITY HOUSING
5	5	HIGH DENSITY HOUSING
6	6	AGRICULTURE
7	7	INDUSTRIAL
8	8	COMMERCIAL
9	9	PASTURE
10	10	WATER BODIES

EXHIBIT 4-2
JANUARY 1979

SAMPLE PROBLEM
ECONOMIC EFFECT OF SINGLE FLOOD
EVENTS ON THE 1990 LAND USE PLAN
DAMAGE REACH NO. 3

DAMAGE REACH 3--LAST SECTION OF WEST FORK

LAND USE CATEGORIES										
1	2	3	4	5	6	7	8	9	10	TOTAL
WATER SURFACE ELEVATIONS										
695.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.60
696.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.70
697.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
698.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
699.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.80
700.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.85
701.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.90
702.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	.95
703.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.00
704.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.05
705.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.05
706.0	0.	0.	0.	0.	15.60	0.	0.	0.	0.	16.75
707.0	0.	0.	0.	0.	16.32	0.	0.	0.	0.	17.37
708.0	0.	0.	0.	0.	17.40	0.	0.	0.	0.	18.75
709.0	0.	0.	0.	0.	17.40	0.	0.	.00	0.	19.05
710.0	0.	0.	0.	0.	17.40	0.	0.	.02	0.	19.08
711.0	0.	0.	0.	0.	65.64	.01	0.	.03	0.	67.63
712.0	0.	0.	0.	0.	134.10	.04	0.	.06	0.	136.30
713.0	0.	0.	0.	0.	176.64	.05	0.	.07	0.	179.06
714.0	0.	0.	0.	0.	207.24	.06	0.	.09	0.	210.19
715.0	0.	0.	0.	0.	223.32	.15	0.	.15	0.	226.82
716.0	0.	0.	0.	0.	290.64	.24	0.	.19	0.	296.62
717.0	0.	0.	0.	0.	357.72	.39	0.	.23	0.	361.94

EXHIBIT 4-3

SAMPLE PROBLEM

FLOOD PROOFING NEW DEVELOPMENT TO A SPECIFIED HEIGHT
ABOVE ZERO STAGE

SAMPLE PROBLEM
FLOOD PROOFING NEW DEVELOPMENT TO
A SPECIFIED HEIGHT ABOVE ZERO STAGE

Problem Statement

Calculate the damages that would result from the 2-year, 10-year, 20-year, 50-year and 100-year flood events if new development (1990 alternative land use pattern) in residential housing, commercial and industrial land uses is flood proofed to a depth of 3 feet (3 feet above zero stage). Request trace output for the medium density residential land use category in damage reach 1. (Table 1 is a listing of the data base file used in the Trail Creek Watershed).

Description of Input Requirements

The key input variable for assessing the above stated conditions is IPROF (J1.2), which designates flood proofing of specified new development a given depth above zero stage. The J5 card defines the land use categories of new development that will be flood proofed and the J6 card assigns the depth of flood proofing to each land use.

The completed coding sheets have been included in this sample problem.

Discussion of Results

The stage-damage function for only one land use category (land use category 4) is included in this sample output. (The stage-damage functions for the other land use categories are identical to those shown in Exhibit 4-2).

The trace output (page 15) indicates that the grid cells (of land use category 4) analyzed have been flood proofed to a depth of 3 feet above the corresponding zero stages (as shown by the printed information tabulated under the

columns labeled "Damage Funct. Stage" and "Damage"). The information at the bottom of page 15 also indicates the total number of grid cells that have been flood proofed to the specified depths (as specified on the J5 and J6 cards) within damage reaches 1 and 3. (In this case 16 grid cells in damage reach 1 and 4 grid cells in damage reach 3 were flood proofed under the above stated conditions).

A comparison of the aggregated damages (for damage reaches 1 and 3) of Exhibits 4-2 and 4-3 shows the following:

- For damage reach 1 a significant reduction in damage occurs at the 2-year flood level whereas no reduction in damage results at the 10-year, 20-year 50-year and 100-year flood levels.
- For damage reach 3 a significant reduction in damage occurs at all of the flood event levels.

It should be noted that the level at which the damage reduction takes place is dependent on the elevation distribution of the grid cells being flood proofed.

TABLE 1
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1	1 2-92	GRID CELL ROW Row 1 Rows 2-92
2	1 2-129	GRID CELL COLUMN Column 1 Columns 2-129
3	1	WATERSHED Trail Creek
5	1 2-5	DAMAGE REACH Damage reach 1 Damage reaches 2-5
10	1 2 3 4 5 6 7 8 9 10	EXISTING LAND USE Natural vegetation Developed open space Low density residential Medium density residential High density residential Agricultural Industrial Commercial Pasture Water bodies
11	1 2 3 4 5 6 7 8 9 10	1990 ALTERNATIVE LAND USE PATTERN Natural vegetation Developed open space Low density residential Medium density residential High density residential Agricultural Industrial Commercial Pasture Water bodies

TABLE 1 (continued)
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
13		REFERENCE FLOOD ELEVATION Flood elevations to the nearest .1 foot are stored for each grid cell in the flood plain
14		TOPOGRAPHIC ELEVATION Land elevations to the nearest .1 foot are stored for each grid cell in the study area

GENERAL PURPOSE DATA FORM
(6 COLUMN FIELDS)

PROGRAM	DATE	EXHIBIT	DATE	DATE	DATE	DATE	DATE	DATE	DATE
DANCA	01/01/79	EXHIBIT 4-3	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79
RESEARCHER	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79	01/01/79
2	3	4	5	6	7	8	9	10	11
SAMPLE PROBLEM									
FLUORO-PHENYLING NEW DEVELOPMENT IN A SPECIFIED									
HEIGHT ABOVE ZERO STAGE									
14	0	0	0	0	0	0	0	0	0
15	1	1	1	1	1	1	1	1	1
16	2	2	2	2	2	2	2	2	2
17	3	3	3	3	3	3	3	3	3
18	4	4	4	4	4	4	4	4	4
19	5	5	5	5	5	5	5	5	5
20	6	6	6	6	6	6	6	6	6
21	7	7	7	7	7	7	7	7	7
22	8	8	8	8	8	8	8	8	8
23	9	9	9	9	9	9	9	9	9
24	10	10	10	10	10	10	10	10	10
25	11	11	11	11	11	11	11	11	11
26	12	12	12	12	12	12	12	12	12
27	13	13	13	13	13	13	13	13	13
28	14	14	14	14	14	14	14	14	14
29	15	15	15	15	15	15	15	15	15
30	16	16	16	16	16	16	16	16	16
31	17	17	17	17	17	17	17	17	17
32	18	18	18	18	18	18	18	18	18
33	19	19	19	19	19	19	19	19	19
34	20	20	20	20	20	20	20	20	20
35	21	21	21	21	21	21	21	21	21
36	22	22	22	22	22	22	22	22	22
37	23	23	23	23	23	23	23	23	23
38	24	24	24	24	24	24	24	24	24
39	25	25	25	25	25	25	25	25	25
40	26	26	26	26	26	26	26	26	26
41	27	27	27	27	27	27	27	27	27
42	28	28	28	28	28	28	28	28	28
43	29	29	29	29	29	29	29	29	29
44	30	30	30	30	30	30	30	30	30
45	31	31	31	31	31	31	31	31	31
46	32	32	32	32	32	32	32	32	32
47	33	33	33	33	33	33	33	33	33
48	34	34	34	34	34	34	34	34	34
49	35	35	35	35	35	35	35	35	35
50	36	36	36	36	36	36	36	36	36
51	37	37	37	37	37	37	37	37	37
52	38	38	38	38	38	38	38	38	38
53	39	39	39	39	39	39	39	39	39
54	40	40	40	40	40	40	40	40	40
55	41	41	41	41	41	41	41	41	41
56	42	42	42	42	42	42	42	42	42
57	43	43	43	43	43	43	43	43	43
58	44	44	44	44	44	44	44	44	44
59	45	45	45	45	45	45	45	45	45
60	46	46	46	46	46	46	46	46	46
61	47	47	47	47	47	47	47	47	47
62	48	48	48	48	48	48	48	48	48
63	49	49	49	49	49	49	49	49	49
64	50	50	50	50	50	50	50	50	50
65	51	51	51	51	51	51	51	51	51
66	52	52	52	52	52	52	52	52	52
67	53	53	53	53	53	53	53	53	53
68	54	54	54	54	54	54	54	54	54
69	55	55	55	55	55	55	55	55	55
70	56	56	56	56	56	56	56	56	56
71	57	57	57	57	57	57	57	57	57
72	58	58	58	58	58	58	58	58	58
73	59	59	59	59	59	59	59	59	59
74	60	60	60	60	60	60	60	60	60
75	61	61	61	61	61	61	61	61	61
76	62	62	62	62	62	62	62	62	62
77	63	63	63	63	63	63	63	63	63
78	64	64	64	64	64	64	64	64	64
79	65	65	65	65	65	65	65	65	65
80	66	66	66	66	66	66	66	66	66
81	67	67	67	67	67	67	67	67	67
82	68	68	68	68	68	68	68	68	68
83	69	69	69	69	69	69	69	69	69
84	70	70	70	70	70	70	70	70	70
85	71	71	71	71	71	71	71	71	71
86	72	72	72	72	72	72	72	72	72
87	73	73	73	73	73	73	73	73	73
88	74	74	74	74	74	74	74	74	74
89	75	75	75	75	75	75	75	75	75
90	76	76	76	76	76	76	76	76	76
91	77	77	77	77	77	77	77	77	77
92	78	78	78	78	78	78	78	78	78
93	79	79	79	79	79	79	79	79	79
94	80	80	80	80	80	80	80	80	80
95	81	81	81	81	81	81	81	81	81
96	82	82	82	82	82	82	82	82	82
97	83	83	83	83	83	83	83	83	83
98	84	84	84	84	84	84	84	84	84
99	85	85	85	85	85	85	85	85	85
100	86	86	86	86	86	86	86	86	86

[illegible]

PROPERTY		DATE		PAGE		RECORD NO.		PAGE		RECORD NO.		PAGE		RECORD NO.		PAGE		RECORD NO.		PAGE	
PROPERTY		DATE		PAGE		RECORD NO.		PAGE		RECORD NO.		PAGE		RECORD NO.		PAGE		RECORD NO.		PAGE	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELDS)

[illegible]

RECEIVED 403
JANUARY 1970

JJ CARD

CC 12345678901234567890123456789012345678901234567890
11 0 2 0

$\text{IPOL} = \begin{matrix} 0 & 0 & 0 & 1 & 0 & 3 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{matrix}$, THERE IS NO POLICY CONTROL IN THIS RUN

$\text{IPROP} = \begin{matrix} 0 & 0 & 0 & 1 & 0 & 3 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{matrix}$, SPECIFIED NEW DEVELOPMENT WILL BE FLOOD PROOFED THE RESPECTIVE AMOUNT IN RELATION TO THE GROUND LEVEL

IEVAC - 0, THERE IS NO PERMANENT EVACUATION IN THIS RUN

REPLY: • THERE IS NO DISSENT EVACUATION IN THIS SUB
ANYONE NOT NOTIFICATION INTERVIEWED OF SUCH

IPRNY = O, NORMAL PRINTOUT

ITRACE = 1, TRACE OUTPUT REQUESTED

IAUTO = 0, NO FILE CREATED FOR ATDDTA PROGRAM

ITYPE = 3, NUMBER OF SINGLE EVENT DAMAGES TO BE CALCULATED

1A6 - 0, NO AGGREGATION OF SINGLE EVENT DAMAGES

J2 CARD

[illegible]**DATA BANK INFORMATION**

NOTE: 1. THE DATA BANK IS ON THIS COMPUTER UNIT

INFORM - 1, THE DATA BANK IS FORMATTED.

ADONIS 0013788X6900001A

92, THE NUMBER OF ROWS IN THE DATA BANK

100% OF THE DATA IN THE DATA SET

IMAGE 0 0, NO PRINTED IMAGE OF INPUT DECK

```

DATA VARIABLE INFORMATION
*****
ISDNRC = 3, THE DATA VARIABLE THAT IS THE DAMAGE REACH CODE
MODR = 2, THE NUMBER OF DAMAGE REACHES IN THIS ANALYSIS
ILAND = 11, THE DATA VARIABLE THAT IS THE LAND USE ANALYZED
ISABE = 10, THE DATA VARIABLE CONSIDERED THE BASE CONDITION
HOLUC = 10, THE NUMBER OF LAND USE CATEGORIES
ITOPD = 14, THE DATA VARIABLE THAT IS TOPOGRAPHY
IRFFD = 13, THE DATA VARIABLE THAT IS THE REFERENCE FLOOD ELEVATION
IELY = 31, THE NUMBER OF ELEVATION-DAMAGE POINTS TO BE CALCULATED

```

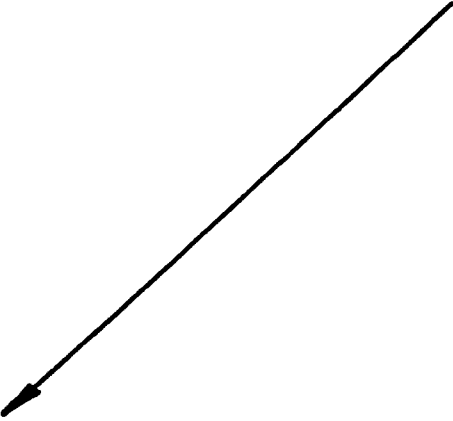
[illegible]

TRACE INFORMATION

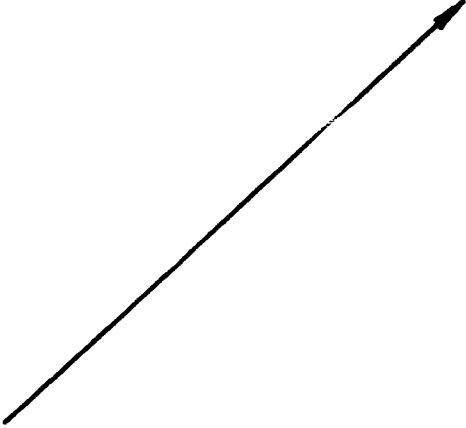
INMR 0 1, TRACE OUTPUT PROVIDED IN THIS DATABASE REACH
INLU 0 0, TRACE OUTPUT PROVIDED FOR THIS LAND USE CATEGORY

CC 120967000123456789001230967000123456789012309670001234567890
PI(12096,0,0)VS.0,NP(0,0)VS.0

FORMAT CARD



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



LAND USE CATEGORY NO. 4				MEDIUM DENSITY HOUSING			
DEPTH	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT	PERCENT
OF	DAMAGE	DAMAGE	DAMAGE	DAMAGE	DAMAGE	DAMAGE	DAMAGE
WATER	STRUCTURE	CONTENTS	OTHER	IN THOUSAND DOLLARS	IN THOUSAND DOLLARS	IN THOUSAND DOLLARS	IN THOUSAND DOLLARS
-2.01	0.	0.	0.	0.	0.	0.	0.
-2.00	1.00	0.	0.	0.	0.	0.	0.
-1.00	2.00	0.	0.	0.	0.	0.	0.
0.	9.00	2.00	0.	0.	0.	0.	0.
1.00	11.00	30.00	0.	0.	0.	0.	0.
2.00	18.00	68.00	0.	0.	0.	0.	0.
3.00	24.00	98.00	0.	0.	0.	0.	0.
4.00	26.00	64.00	0.	0.	0.	0.	0.
5.00	29.00	68.00	0.	0.	0.	0.	0.
6.00	31.00	70.00	0.	0.	0.	0.	0.
7.00	32.00	71.00	0.	0.	0.	0.	0.
8.00	35.00	71.00	0.	0.	0.	0.	0.
9.00	36.00	73.00	0.	0.	0.	0.	0.
10.00	36.00	74.00	0.	0.	0.	0.	0.
11.00	40.00	74.00	0.	0.	0.	0.	0.
12.00	40.00	74.00	0.	0.	0.	0.	0.
13.00	41.00	74.00	0.	0.	0.	0.	0.
14.00	42.00	74.00	0.	0.	0.	0.	0.
15.00	43.00	74.00	0.	0.	0.	0.	0.
16.00	44.00	74.00	0.	0.	0.	0.	0.
17.00	45.00	74.00	0.	0.	0.	0.	0.
18.00	45.00	74.00	0.	0.	0.	0.	0.
19.00	45.00	74.00	0.	0.	0.	0.	0.
20.00	45.00	74.00	0.	0.	0.	0.	0.

DENSITY OF THE LAND USE UNITS PER GRID CELL = 4.00

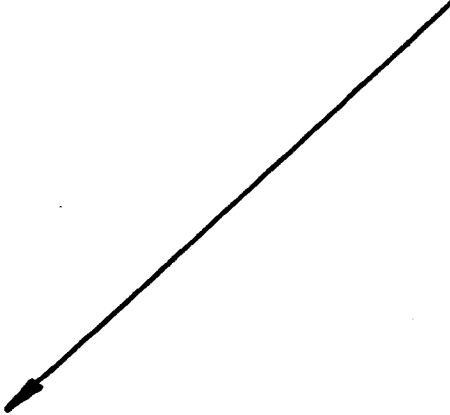
BASE VALUE OF THE STRUCTURE = 1000.00

BASE VALUE OF THE CONTENTS (30.00 PERCENT OF THE STRUCTURE VALUE) =

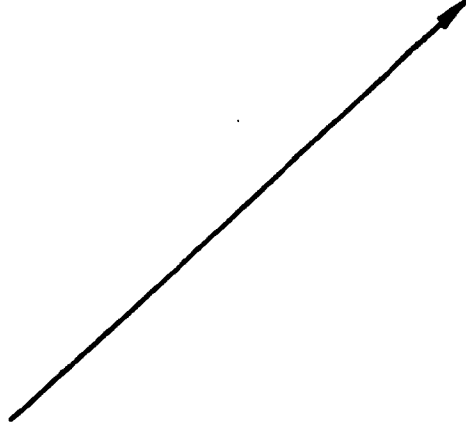
100% VALUE OF OTHERS = 0.

WACANCY FACTOR (PERCENTY DEVELOPED) = 70.0

ONLY NEW DEVELOPMENT IN THIS LAND USE WILL BE PLACED PROPOSED 3.0 FEET



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



SAMPLE PROBLEM
FLOOD PROOFING NEW DEVELOPMENT TO A SPECIFIED
WINDSTAGE ABOVE ZERO STAGE

GENESEE 4-3
JANUARY 1970

DAMAGE REACH INDEX LOCATION SUMMARY

DAMAGE REACH NO.	REFERENCE FLOOD ELEVATION	POLICY FLOOD ELEVATION	FLOOD PROOFING ELEVATION	EVACUATION ELEVATION	STARTING DAMAGE ELEVATION	DAMAGE ELEVATION INCREMENT	AGGREGATED DAMAGE RCH. ID.	MODIFY LAND USE BENEFIT
1.	634.0	0.	0.	0.	610.0	1.00	0	0
3.	714.0	0.	0.	0.	694.0	1.00	0	0

SINGLE EVENTS FOR DAMAGE REACHES

DAMAGE REACH NO.	2 YEAR EVENT	10 YEAR EVENT	20 YEAR EVENT	50 YEAR EVENT	100 YEAR EVENT
1.	614.7	623.5	624.0	625.6	627.1
3.	708.6	710.2	710.8	711.3	711.9

SAMPLE PROBLEM
 FLOOD PROOFING NEW DEVELOPMENT TO A SPECIFIED
 HEIGHT ABOVE ZERO STATE
 DANGER REACH NO. 1
 DANGER REACH 1-000000 TO COMPLIANCE

EXHIBIT 4-3
 JANUARY 1979

SURFACE ELEVATION	LAND USE CATEGORIES												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
610.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
611.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
612.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
613.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
614.0	.15	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.15
615.0	.15	0.	0.	0.	0.	0.	0.	0.	.07	0.	0.	0.	.22
616.0	.15	0.	0.	0.	0.	0.	0.	0.	.10	0.	0.	0.	.25
617.0	.20	0.	0.	0.	0.	0.	0.	0.	.12	0.	0.	0.	.32
618.0	.25	0.	0.	12.04	0.	0.	935.13	0.	.15	0.	0.	0.	948.19
619.0	.25	0.	0.	13.93	0.	0.	1070.49	0.	.18	0.	0.	0.	1092.75
620.0	.35	0.	0.	14.56	0.	0.	1148.07	0.	.25	0.	0.	0.	1177.85
621.0	.40	0.	0.	14.92	0.	0.	1230.90	0.	.27	0.	0.	0.	1264.90
622.0	.45	0.	0.	15.76	0.	0.	1307.10	0.	.29	0.	0.	0.	1343.44
623.0	.45	0.	0.	16.21	0.	0.	1393.90	0.	.31	0.	0.	0.	1428.07
624.0	.48	.30	0.	16.36	0.	0.	1468.19	0.	.33	0.	0.	0.	1509.67
625.0	.55	.34	0.	17.42	0.	0.	1592.48	0.	.39	0.	0.	0.	1631.14
626.0	.55	.34	0.	17.42	0.	0.	1650.10	0.	.41	0.	0.	0.	1691.64
627.0	.70	.34	0.	17.70	0.	0.	1770.72	0.	.42	0.	0.	0.	1812.64
628.0	.67	.40	0.	17.90	0.	0.	1900.70	0.	.46	0.	0.	0.	2016.43
629.0	.90	.40	0.	18.26	0.	0.	2013.36	0.	.49	0.	0.	0.	2133.40
630.0	1.10	.40	0.	18.94	0.	0.	2020.37	0.	.52	0.	0.	0.	2093.15
631.0	1.15	.40	0.	19.42	0.	0.	2020.72	0.	.55	0.	0.	0.	2095.64
632.0	1.15	.40	0.	19.42	0.	0.	2020.75	0.	.56	0.	0.	0.	2096.49

Exhibit 4-3
17 of 19

SIMPLE PROBLEM
 PLANNING NEW DEVELOPMENT TO A SPECIFIED
 HEIGHT ABOVE FIRM STAGE
 DAMAGE REACH NO. 3
 DAMAGE REACH 3-LAST SECTION OF WEST FARM

SUNDAY 4-3
 JANUARY 1970

LAND USE CATEGORIES													TOTAL
WATER SURFACE ELEVATION	1	2	3	4	5	6	7	8	9	10	11	12	
695.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
696.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.70
697.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
698.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
699.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
700.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
701.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
702.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
703.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
704.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
705.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
706.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
707.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
708.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
709.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
710.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
711.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
712.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
713.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
714.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
715.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
716.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00
717.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.00

EXHIBIT 4-4

SAMPLE PROBLEM

**FLOOD PROOFING NEW DEVELOPMENT TO THE
EXISTING 100-YEAR FLOOD LEVEL**

SAMPLE PROBLEM
FLOOD PROOFING NEW DEVELOPMENT TO THE
EXISTING 100-YEAR FLOOD LEVEL

Problem Statement

Flood proof new development (1990 alternative land use pattern) in residential housing, commercial and industrial land uses to the existing 100-year flood level. (In this case the 100-year flood level for the existing or base land use pattern is assumed to be the same as the 100-year level for the 1990 land use pattern. If possible, the user should estimate flood levels for future conditions and input those levels when analyzing future alternatives). Request trace output for the medium density residential land use category in damage reach 1 and obtain damage values for the 2-year, 10-year, 20-year, 50-year and 100-year flood events. (Table 1 is a listing of the data base file used in the Trail Creek Watershed).

Description of Input Requirements

The key input variable for assessing the above stated conditions is IPROF (J1.2), to indicate flood proofing of new development to a specified level. The J5 card is used to designate the land use categories to be protected and the 100-year flood protection elevation is input on the DR card (the 100-year elevation on the DR card should correspond to the 100-year elevation on the SE card).

The completed coding sheets have been included in this sample problem.

Discussion of Results

An inspection of the trace output shows that land use category 4 in damage reach 1 is flood proofed to the 100-year level (no damage results until the 100-year flood event elevation at the index location is exceeded). In this

case the 100-year flood elevation at the index location is 627.1 feet and as shown by the column labeled "Damage" no damage occurs until an elevation of 628 feet is reached.

The note printed below the trace information reveals the total number of grid cells in damage reaches 1 and 3 that were flood proofed to the specified target level.

A comparison of the aggregated damage tables of Exhibits 4-2 and 4-4, show a significant reduction in damage up to the 100-year flood event levels specified due to this flood proofing option. The user can check the accuracy of this flood proofing option since all aggregated damage values (of this sample problem) above the target protection level specified should agree with the corresponding values shown in Exhibit 4-2.

TABLE 1
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1	1	GRID CELL ROW
	2-92	Row 1 Rows 2-92
2	1	GRID CELL COLUMN
	2-129	Column 1 Columns 2-129
3	1	WATERSHED Trail Creek
5	1	DAMAGE REACH
	2-5	Damage reach 1 Damage reaches 2-5
10	1	EXISTING LAND USE
	2	Natural vegetation
	3	Developed open space
	4	Low density residential
	5	Medium density residential
	6	High density residential
	7	Agricultural
	8	Industrial
	9	Commercial
	10	Pasture Water bodies
11	1	1990 ALTERNATIVE LAND USE PATTERN
	2	Natural vegetation
	3	Developed open space
	4	Low density residential
	5	Medium density residential
	6	High density residential
	7	Agricultural
	8	Industrial
	9	Commercial
	10	Pasture Water bodies

TABLE 1 (continued)
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
13		REFERENCE FLOOD ELEVATION Flood elevations to the nearest .1 foot are stored for each grid cell in the flood plain
14		TOPOGRAPHIC ELEVATION Land elevations to the nearest .1 foot are stored for each grid cell in the study area

GENERAL PURPOSE DATA FORM

PROGRAM		DATE		PAGE					
SUBJECT		DATE		PAGE					
1	2	3	4	5	6	7	8	9	10
<p>1. DANCAL - EXHIBIT 3-1</p> <p>2. DANCAL</p> <p>3. DANCAL</p> <p>4. DANCAL</p> <p>5. DANCAL</p> <p>6. DANCAL</p> <p>7. DANCAL</p> <p>8. DANCAL</p> <p>9. DANCAL</p> <p>10. DANCAL</p> <p>11. DANCAL</p> <p>12. DANCAL</p> <p>13. DANCAL</p> <p>14. DANCAL</p> <p>15. DANCAL</p> <p>16. DANCAL</p> <p>17. DANCAL</p> <p>18. DANCAL</p> <p>19. DANCAL</p> <p>20. DANCAL</p> <p>21. DANCAL</p> <p>22. DANCAL</p> <p>23. DANCAL</p> <p>24. DANCAL</p> <p>25. DANCAL</p> <p>26. DANCAL</p> <p>27. DANCAL</p> <p>28. DANCAL</p> <p>29. DANCAL</p> <p>30. DANCAL</p> <p>31. DANCAL</p> <p>32. DANCAL</p> <p>33. DANCAL</p> <p>34. DANCAL</p> <p>35. DANCAL</p> <p>36. DANCAL</p> <p>37. DANCAL</p> <p>38. DANCAL</p> <p>39. DANCAL</p> <p>40. DANCAL</p> <p>41. DANCAL</p> <p>42. DANCAL</p> <p>43. DANCAL</p> <p>44. DANCAL</p> <p>45. DANCAL</p> <p>46. DANCAL</p> <p>47. DANCAL</p> <p>48. DANCAL</p> <p>49. DANCAL</p> <p>50. DANCAL</p> <p>51. DANCAL</p> <p>52. DANCAL</p> <p>53. DANCAL</p> <p>54. DANCAL</p> <p>55. DANCAL</p> <p>56. DANCAL</p> <p>57. DANCAL</p> <p>58. DANCAL</p> <p>59. DANCAL</p> <p>60. DANCAL</p> <p>61. DANCAL</p> <p>62. DANCAL</p> <p>63. DANCAL</p> <p>64. DANCAL</p> <p>65. DANCAL</p> <p>66. DANCAL</p> <p>67. DANCAL</p> <p>68. DANCAL</p> <p>69. DANCAL</p> <p>70. DANCAL</p> <p>71. DANCAL</p> <p>72. DANCAL</p> <p>73. DANCAL</p> <p>74. DANCAL</p> <p>75. DANCAL</p> <p>76. DANCAL</p> <p>77. DANCAL</p> <p>78. DANCAL</p> <p>79. DANCAL</p> <p>80. DANCAL</p> <p>81. DANCAL</p> <p>82. DANCAL</p> <p>83. DANCAL</p> <p>84. DANCAL</p> <p>85. DANCAL</p> <p>86. DANCAL</p> <p>87. DANCAL</p> <p>88. DANCAL</p> <p>89. DANCAL</p> <p>90. DANCAL</p> <p>91. DANCAL</p> <p>92. DANCAL</p> <p>93. DANCAL</p> <p>94. DANCAL</p> <p>95. DANCAL</p> <p>96. DANCAL</p> <p>97. DANCAL</p> <p>98. DANCAL</p> <p>99. DANCAL</p> <p>100. DANCAL</p>									

[illegible]

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELDS)

PROJECT		SUBJECT		DATE		PAGE	
DAMCAL - EXHIBIT 7-7		STRUCTURE		FEBRUARY 1979		3	
1	2	3	4	5	6	7	8
CT	6	AGRICULTURE					
DF	0	30.5	70	51.5	61.5	60.5	60.5
DS	0	0	0	0	0	0	0
DT	0	0	0	0	0	0	0
DU	0	0	0	0	0	0	0
DV	0	0	0	0	0	0	0
DW	0	0	0	0	0	0	0
DX	0	0	0	0	0	0	0
DY	0	0	0	0	0	0	0
DZ	0	0	0	0	0	0	0
EA	0	0	0	0	0	0	0
EB	0	0	0	0	0	0	0
EC	0	0	0	0	0	0	0
ED	0	0	0	0	0	0	0
EE	0	0	0	0	0	0	0
EF	0	0	0	0	0	0	0
EG	0	0	0	0	0	0	0
EH	0	0	0	0	0	0	0
EI	0	0	0	0	0	0	0
EJ	0	0	0	0	0	0	0
EK	0	0	0	0	0	0	0
EL	0	0	0	0	0	0	0
EM	0	0	0	0	0	0	0
EN	0	0	0	0	0	0	0
EO	0	0	0	0	0	0	0
EP	0	0	0	0	0	0	0
EQ	0	0	0	0	0	0	0
ER	0	0	0	0	0	0	0
ES	0	0	0	0	0	0	0
ET	0	0	0	0	0	0	0
EU	0	0	0	0	0	0	0
EV	0	0	0	0	0	0	0
EW	0	0	0	0	0	0	0
EX	0	0	0	0	0	0	0
EY	0	0	0	0	0	0	0
EZ	0	0	0	0	0	0	0
FA	0	0	0	0	0	0	0
FB	0	0	0	0	0	0	0
FC	0	0	0	0	0	0	0
FD	0	0	0	0	0	0	0
FE	0	0	0	0	0	0	0
FF	0	0	0	0	0	0	0
FG	0	0	0	0	0	0	0
FH	0	0	0	0	0	0	0
FI	0	0	0	0	0	0	0
FJ	0	0	0	0	0	0	0
FK	0	0	0	0	0	0	0
FL	0	0	0	0	0	0	0
FM	0	0	0	0	0	0	0
FN	0	0	0	0	0	0	0
FO	0	0	0	0	0	0	0
FP	0	0	0	0	0	0	0
FQ	0	0	0	0	0	0	0
FR	0	0	0	0	0	0	0
FS	0	0	0	0	0	0	0
FT	0	0	0	0	0	0	0
FU	0	0	0	0	0	0	0
FV	0	0	0	0	0	0	0
FW	0	0	0	0	0	0	0
FX	0	0	0	0	0	0	0
FY	0	0	0	0	0	0	0
FZ	0	0	0	0	0	0	0
GA	0	0	0	0	0	0	0
GB	0	0	0	0	0	0	0
GC	0	0	0	0	0	0	0
GD	0	0	0	0	0	0	0
GE	0	0	0	0	0	0	0
GF	0	0	0	0	0	0	0
GG	0	0	0	0	0	0	0
GH	0	0	0	0	0	0	0
GI	0	0	0	0	0	0	0
GJ	0	0	0	0	0	0	0
GK	0	0	0	0	0	0	0
GL	0	0	0	0	0	0	0
GM	0	0	0	0	0	0	0
GN	0	0	0	0	0	0	0
GO	0	0	0	0	0	0	0
GP	0	0	0	0	0	0	0
GQ	0	0	0	0	0	0	0
GR	0	0	0	0	0	0	0
GS	0	0	0	0	0	0	0
GT	0	0	0	0	0	0	0
GU	0	0	0	0	0	0	0
GV	0	0	0	0	0	0	0
GW	0	0	0	0	0	0	0
GX	0	0	0	0	0	0	0
GY	0	0	0	0	0	0	0
GZ	0	0	0	0	0	0	0
HA	0	0	0	0	0	0	0
HB	0	0	0	0	0	0	0
HC	0	0	0	0	0	0	0
HD	0	0	0	0	0	0	0
HE	0	0	0	0	0	0	0
HF	0	0	0	0	0	0	0
HG	0	0	0	0	0	0	0
HH	0	0	0	0	0	0	0
HI	0	0	0	0	0	0	0
HJ	0	0	0	0	0	0	0
HK	0	0	0	0	0	0	0
HL	0	0	0	0	0	0	0
HM	0	0	0	0	0	0	0
HN	0	0	0	0	0	0	0
HO	0	0	0	0	0	0	0
HP	0	0	0	0	0	0	0
HQ	0	0	0	0	0	0	0
HR	0	0	0	0	0	0	0
HS	0	0	0	0	0	0	0
HT	0	0	0	0	0	0	0
HU	0	0	0	0	0	0	0
HV	0	0	0	0	0	0	0
HW	0	0	0	0	0	0	0
HX	0	0	0	0	0	0	0
HY	0	0	0	0	0	0	0
HZ	0	0	0	0	0	0	0
IA	0	0	0	0	0	0	0
IB	0	0	0	0	0	0	0
IC	0	0	0	0	0	0	0
ID	0	0	0	0	0	0	0
IE	0	0	0	0	0	0	0
IF	0	0	0	0	0	0	0
IG	0	0	0	0	0	0	0
IH	0	0	0	0	0	0	0
II	0	0	0	0	0	0	0
IJ	0	0	0	0	0	0	0
IK	0	0	0	0	0	0	0
IL	0	0	0	0	0	0	0
IM	0	0	0	0	0	0	0
IN	0	0	0	0	0	0	0
IO	0	0	0	0	0	0	0
IP	0	0	0	0	0	0	0
IQ	0	0	0	0	0	0	0
IR	0	0	0	0	0	0	0
IS	0	0	0	0	0	0	0
IT	0	0	0	0	0	0	0
IU	0	0	0	0	0	0	0
IV	0	0	0	0	0	0	0
IW	0	0	0	0	0	0	0
IX	0	0	0	0	0	0	0
IY	0	0	0	0	0	0	0
IZ	0	0	0	0	0	0	0
JA	0	0	0	0	0	0	0
JB	0	0	0	0	0	0	0
JC	0	0	0	0	0	0	0
JD	0	0	0	0	0	0	0
JE	0	0	0	0	0	0	0
JF	0	0	0	0	0	0	0
JG	0	0	0	0	0	0	0
JH	0	0	0	0	0	0	0
JI	0	0	0	0	0	0	0
JJ	0	0	0	0	0	0	0
JK	0	0	0	0	0	0	0
JL	0	0	0	0	0	0	0
JM	0	0	0	0	0	0	0
JN	0	0	0	0	0	0	0
JO	0	0	0	0	0	0	0
JP	0	0	0	0	0	0	0
JQ	0	0	0	0	0	0	0
JR	0	0	0	0	0	0	0
JS	0	0	0	0	0	0	0
JT	0	0	0	0	0	0	0
JU	0	0	0	0	0	0	0
JV	0	0	0	0	0	0	0
JW	0	0	0	0	0	0	0
JX	0	0	0	0	0	0	0
JY	0	0	0	0	0	0	0
JZ	0	0	0	0	0	0	0
KA	0	0	0	0	0	0	0
KB	0	0	0	0	0	0	0
KC	0	0	0	0	0	0	0
KD	0	0	0	0	0	0	0
KE	0	0	0	0	0	0	0
KF	0	0	0	0	0	0	0
KG	0	0	0	0	0	0	0
KH	0	0	0	0	0	0	0
KI	0	0	0	0	0	0	0
KJ	0	0	0	0	0	0	0
KK	0	0	0	0	0	0	0
KL	0	0	0	0	0	0	0
KM	0	0	0	0	0	0	0
KN	0	0	0	0	0	0	0
KO	0	0	0	0	0	0	0
KP	0	0	0	0	0	0	0
KQ	0	0	0	0	0	0	0
KR	0	0	0	0	0	0	0
KS	0	0	0	0	0	0	0
KT	0	0	0	0	0	0	0
KU	0	0	0	0	0	0	0
KV	0	0	0	0	0	0	0
KW	0	0	0	0	0	0	0
KX	0	0	0	0	0	0	0
KY	0	0	0	0	0	0	0
KZ	0	0	0	0	0	0	0

FORMER		RECORDED BY		EXHIBIT		RECORDED BY		DATE		PAGE	
DANCAL - EXHIBIT 2-1		D. Buehler		2-1		D. Buehler		January 1979		1	
1	2	3	4	5	6	7	8	9	10	11	12
DA	0	5	5	5	5	5	5	5	5	5	5
LV	10	1	1	0	0	0	0	0	0	0	0
LT	10	WATER APPLIES									
DF	0	10									
RS	0	0									
DT	0	0									
DA	0	0									
DR	1	634									
DPT DORANGE REACH 3-4-ANNEE TO CANALFENCE											
SE	614.7	623.5	624.0	625.6	627.1	610	1	0			
DPR	5	714									
DPT DORANGE REACH 3-LAST SECTION OF WEST FARM											
SE	208.6	210.2	210.8	211.5	211.9						
END											

SAMPLE PROBLEM
FLOOD PROOFING NEW DEVELOPMENT TO THE EXISTING
100-YEAR FLOOD LEVEL EXHIBIT 4-4
JANUARY 1979

J1 CARD

CC 12345678901234567890123456789012345678901234567890
J1 0 4 0 0 0 1 0 3
IPOL = 0, THERE IS NO POLICY CONTROL IN THIS RUN
IPROF = 0, SPECIFIED NEW DEVELOPMENT WILL BE FLOOD PROOFED TO A SPECIFIED LEVEL
IEVAC = 0, THERE IS NO PERMANENT EVACUATION IN THIS RUN
IEVCLU = 0, THERE IS NO PERMANENT EVACUATION IN THIS RUN
IPRNT = 0, NORMAL PRINTOUT
ITRACE = 1, TRACE OUTPUT REQUESTED
IAUTO = 0, NO FILE CREATED FOR ATOSTA PROGRAM
ITYPE = 3, NUMBER OF SINGLE EVENT DAMAGES TO BE CALCULATED
IAB = 0, NO AGGREGATION OF SINGLE EVENT DAMAGES

J2 CARD

CC 12345678901234567890123456789012345678901234567890
J2 1 1 10 42 124 0
DATA BANK INFORMATION

IWPLE = 1, THE DATA BANK IS ON THIS COMPUTER UNIT
IWRN = 1, THE DATA BANK IS FORMATTED
INOV = 10, THE NUMBER OF DATA VARIABLES
IRSN = 02, THE NUMBER OF ROWS IN THE DATA BANK
ICOL = 120, THE NUMBER OF COLUMNS IN THE DATA BANK
INAGE = 0, NO PRINTED IMAGE OF INPUT DECK

J3 CARD

CC 123456789012345678901234567890123456789012345678901234567890
J3 3 2 11 10 10 13 31

DATA VARIABLE INFORMATION

IDAMHC = 9, THE DATA VARIABLE THAT IS THE DAMAGE REACH CODE
NDOR = 2, THE NUMBER OF DAMAGE REACHES IN THIS ANALYSIS
ILAND = 11, THE DATA VARIABLE THAT IS THE LAND USE ANALYZED
IBASE = 10, THE DATA VARIABLE CONSIDERED THE BASE CONDITION
HOLUC = 10, THE NUMBER OF LAND USE CATEGORIES
ITOPD = 10, THE DATA VARIABLE THAT IS TOPOGRAPHY
IOPPD = 13, THE DATA VARIABLE THAT IS THE REFERENCE FLOOD ELEVATION
IELV = 31, THE NUMBER OF ELEVATION-DAMAGE POINTS TO BE CALCULATED

THE FOLLOWING LAND USE CATEGORIES WITH NEW
DEVELOPMENT ARE SUBJECT TO FLOOD PROBING

J3 3 2 11 10 10 13 31
CC 123456789012345678901234567890123456789012345678901234567890

J3 CARD

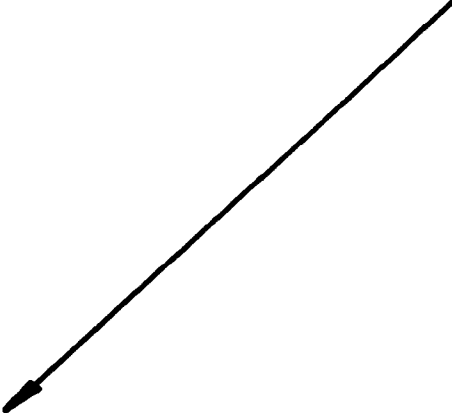
CC 123456789012345678901234567890123456789012345678901234567890
J3 1 4

TRACE INFORMATION

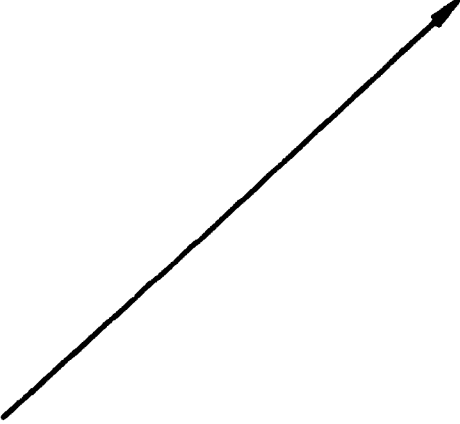
NDOR = 1, TRACE OUTPUT PROVIDED IN THIS DAMAGE REACH
HOLU = 4, TRACE OUTPUT PROVIDED FOR THIS LAND USE CATEGORY

FORMAT CARD

CC 123456789012345678901234567890123456789012345678901234567890
P(1234567890,1234567890,1234567890,1234567890,1234567890,1234567890)



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



LAND USE CATEGORY NO. 4				
MEDIUM DENSITY HOUSING				
DEPTH	PERCENT	PERCENT	PERCENT	AMOUNT OF DAMAGE
OF	DAMAGE	DAMAGE	DAMAGE	PER GRID CELL
WATER	STRUCTURE	CONTENTS	OTHER	IN THOUSAND DOLLARS
-5.01	0.	0.	0.	0.
-5.00	1.00	0.	5.00	.20
-1.00	2.00	0.	5.00	.50
0.	9.00	2.00	5.00	2.49
1.00	11.00	30.00	5.00	5.00
2.00	18.00	40.00	5.00	9.07
3.00	24.00	55.00	5.00	11.50
4.00	26.00	64.00	5.00	12.00
5.00	29.00	69.00	5.00	13.03
6.00	31.00	70.00	4.00	10.50
7.00	32.00	71.00	4.00	10.92
8.00	33.00	71.00	4.00	15.76
9.00	36.00	73.00	4.00	16.21
10.00	39.00	74.00	4.00	16.30
11.00	40.00	74.00	3.00	17.42
12.00	40.00	74.00	3.00	17.42
13.00	41.00	74.00	3.00	17.70
14.00	42.00	74.00	3.00	17.96
15.00	43.00	74.00	3.00	18.26
16.00	44.00	74.00	2.00	18.34
17.00	45.00	74.00	2.00	18.62
18.00	45.00	74.00	2.00	18.62
19.00	45.00	74.00	2.00	18.62
20.00	45.00	74.00	2.00	18.62

DENSITY OF THE LAND USE UNITS PER GRID CELL = 4.00

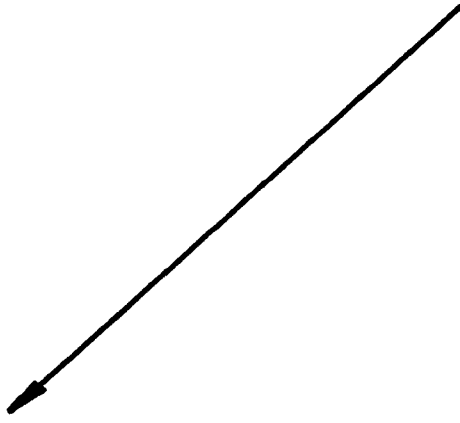
BASE VALUE OF THE STRUCTURE = 10000.00

MADE VALUE OF THE CONTENTS (30.00 PERCENT OF THE STRUCTURE VALUE) = 3000.00

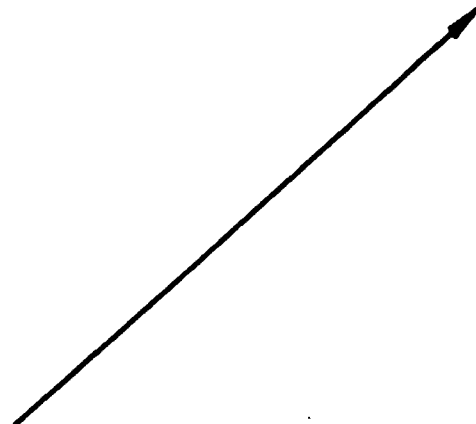
BASE VALUE OF OTHER S -0.

VACANCY FACTOR (PERCENT DEVELOPED) = 70.0

ONLY NEW DEVELOPMENT IN THIS LAND USE WILL BE FLOOD PROOFED TO A SPECIFIED PROTECTION LEVEL



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



SAMPLE PROBLEM
FLOOD PROOFING NEW DEVELOPMENT TO THE EXISTING
100-YEAR FLOOD LEVEL

EXHIBIT 4-4
JANUARY 1979

DAMAGE REACH INDEX LOCATION SUMMARY

ID. NO.	REFERENCE FLOOD ELEVATION	POLICY FLOOD ELEVATION	FLOOD PROOFING ELEVATION	EVACUATION ELEVATION	STARTING DAMAGE ELEVATION	DAMAGE ELEVATION INCREMENT	AGGREGATED DAMAGE RCH. IS.	MODIFY LAND USE SENSITV
1.	634.0	0.	627.1	0.	610.0	1.00	0	0
3.	714.0	0.	711.9	0.	695.0	1.00	0	0

SINGLE EVENTS FOR DAMAGE REACHES

DAMAGE REACH NO.	2 YEAR EVENT	10 YEAR EVENT	20 YEAR EVENT	50 YEAR EVENT	100 YEAR EVENT
1.	616.7	623.2	624.0	625.6	627.1
3.	708.6	710.2	710.0	711.5	711.9

• INDICATES ELEVATION IS AT GRID CELL

DAMAGE REACH 1 WAS 16. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVEL
DAMAGE REACH 3 WAS 4. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVEL
DAMAGE REACH 4. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVEL

DAMAGE REACH 3 HAS 12. CELLS WITH DAMAGES STANDING BELOW THE STANDING AGGREGATION ELEVATION

DAMAGE REACH 1 HAS 100, CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION
DAMAGE REACH 3 HAS 137, CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION

SAMPLE PROBLEM
FLOOD PROOFING NEW DEVELOPMENT TO THE EXISTING
100-YEAR FLOOD LEVEL
DAMAGE REACH NO. 1
DAMAGE REACH 1-OCOMEET TO COMPLIANCE

EXHIBIT 4-4
JANUARY 1970

LAND USE CATEGORIES											
WATER	1	2	3	4	5	6	7	8	9	10	TOTAL
SURFACE ELEVATIONS											
610.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
611.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
612.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
613.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
614.0	.13	0.	0.	0.	0.	0.	0.	0.	0.	0.	.13
615.0	.15	0.	0.	0.	0.	0.	0.	0.	.07	0.	.22
616.0	.15	0.	0.	0.	0.	0.	0.	0.	.10	0.	.25
617.0	.20	0.	0.	0.	0.	0.	0.	0.	.12	0.	.32
618.0	.27	0.	0.	0.	0.	0.	0.	0.	.13	0.	.40
619.0	.25	0.	0.	0.	0.	0.	0.	0.	.18	0.	.43
620.0	.35	0.	0.	0.	0.	0.	0.	0.	.23	0.	.58
621.0	.40	0.	0.	0.	0.	0.	0.	0.	.27	0.	.67
622.0	.45	0.	0.	0.	0.	0.	0.	0.	.29	0.	.74
623.0	.45	0.	0.	0.	0.	0.	0.	0.	.31	0.	.76
624.0	.35	.30	0.	0.	0.	0.	0.	0.	.33	0.	1.18
625.0	.35	.30	0.	0.	0.	0.	0.	0.	.39	0.	1.24
626.0	.35	.30	0.	0.	0.	0.	0.	0.	.41	0.	1.26
627.0	.70	.30	0.	0.	0.	0.	0.	0.	.43	0.	1.43
627.1	.70	.40	0.	0.	0.	0.	0.	0.	.43	0.	1.53
628.0	.80	.40	0.	17.98	0.	0.	1904.79	0.	.46	0.	2010.33
629.0	.90	.40	0.	18.26	0.	0.	2013.36	6.48	.49	0.	2039.80
630.0	1.10	.40	0.	18.34	0.	0.	2024.97	10.46	.52	0.	2064.39
631.0	1.15	.40	0.	18.42	0.	0.	2024.92	32.31	.55	0.	2076.35

DAMAGE CATEGORY	LAND USE CODE	LAND USE	1980	1985	1990	2000	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120	2130	2140	2150	2160	2170	2180	2190	2200	2210	2220	2230	2240	2250	2260	2270	2280	2290	2300	2310	2320	2330	2340	2350	2360	2370	2380	2390	2400	2410	2420	2430	2440	2450	2460	2470	2480	2490	2500	2510	2520	2530	2540	2550	2560	2570	2580	2590	2600	2610	2620	2630	2640	2650	2660	2670	2680	2690	2700	2710	2720	2730	2740	2750	2760	2770	2780	2790	2800	2810	2820	2830	2840	2850	2860	2870	2880	2890	2900	2910	2920	2930	2940	2950	2960	2970	2980	2990	3000	3010	3020	3030	3040	3050	3060	3070	3080	3090	3100	3110	3120	3130	3140	3150	3160	3170	3180	3190	3200	3210	3220	3230	3240	3250	3260	3270	3280	3290	3300	3310	3320	3330	3340	3350	3360	3370	3380	3390	3400	3410	3420	3430	3440	3450	3460	3470	3480	3490	3500	3510	3520	3530	3540	3550	3560	3570	3580	3590	3600	3610	3620	3630	3640	3650	3660	3670	3680	3690	3700	3710	3720	3730	3740	3750	3760	3770	3780	3790	3800	3810	3820	3830	3840	3850	3860	3870	3880	3890	3900	3910	3920	3930	3940	3950	3960	3970	3980	3990	4000	4010	4020	4030	4040	4050	4060	4070	4080	4090	4100	4110	4120	4130	4140	4150	4160	4170	4180	4190	4200	4210	4220	4230	4240	4250	4260	4270	4280	4290	4300	4310	4320	4330	4340	4350	4360	4370	4380	4390	4400	4410	4420	4430	4440	4450	4460	4470	4480	4490	4500	4510	4520	4530	4540	4550	4560	4570	4580	4590	4600	4610	4620	4630	4640	4650	4660	4670	4680	4690	4700	4710	4720	4730	4740	4750	4760	4770	4780	4790	4800	4810	4820	4830	4840	4850	4860	4870	4880	4890	4900	4910	4920	4930	4940	4950	4960	4970	4980	4990	5000	5010	5020	5030	5040	5050	5060	5070	5080	5090	5100	5110	5120	5130	5140	5150	5160	5170	5180	5190	5200	5210	5220	5230	5240	5250	5260	5270	5280	5290	5300	5310	5320	5330	5340	5350	5360	5370	5380	5390	5400	5410	5420	5430	5440	5450	5460	5470	5480	5490	5500	5510	5520	5530	5540	5550	5560	5570	5580	5590	5600	5610	5620	5630	5640	5650	5660	5670	5680	5690	5700	5710	5720	5730	5740	5750	5760	5770	5780	5790	5800	5810	5820	5830	5840	5850	5860	5870	5880	5890	5900	5910	5920	5930	5940	5950	5960	5970	5980	5990	6000	6010	6020	6030	6040	6050	6060	6070	6080	6090	6100	6110	6120	6130	6140	6150	6160	6170	6180	6190	6200	6210	6220	6230	6240	6250	6260	6270	6280	6290	6300	6310	6320	6330	6340	6350	6360	6370	6380	6390	6400	6410	6420	6430	6440	6450	6460	6470	6480	6490	6500	6510	6520	6530	6540	6550	6560	6570	6580	6590	6600	6610	6620	6630	6640	6650	6660	6670	6680	6690	6700	6710	6720	6730	6740	6750	6760	6770	6780	6790	6800	6810	6820	6830	6840	6850	6860	6870	6880	6890	6900	6910	6920	6930	6940	6950	6960	6970	6980	6990	7000	7010	7020	7030	7040	7050	7060	7070	7080	7090	7100	7110	7120	7130	7140	7150	7160	7170	7180	7190	7200	7210	7220	7230	7240	7250	7260	7270	7280	7290	7300	7310	7320	7330	7340	7350	7360	7370	7380	7390	7400	7410	7420	7430	7440	7450	7460	7470	7480	7490	7500	7510	7520	7530	7540	7550	7560	7570	7580	7590	7600	7610	7620	7630	7640	7650	7660	7670	7680	7690	7700	7710	7720	7730	7740	7750	7760	7770	7780	7790	7800	7810	7820	7830	7840	7850	7860	7870	7880	7890	7900	7910	7920	7930	7940	7950	7960	7970	7980	7990	8000	8010	8020	8030	8040	8050	8060	8070	8080	8090	8100	8110	8120	8130	8140	8150	8160	8170	8180	8190	8200	8210	8220	8230	8240	8250	8260	8270	8280	8290	8300	8310	8320	8330	8340	8350	8360	8370	8380	8390	8400	8410	8420	8430	8440	8450	8460	8470	8480	8490	8500	8510	8520	8530	8540	8550	8560	8570	8580	8590	8600	8610	8620	8630	8640	8650	8660	8670	8680	8690	8700	8710	8720	8730	8740	8750	8760	8770	8780	8790	8800	8810	8820	8830	8840	8850	8860	8870	8880	8890	8900	8910	8920	8930	8940	8950	8960	8970	8980	8990	9000	9010	9020	9030	9040	9050	9060	9070	9080	9090	9100	9110	9120	9130	9140	9150	9160	9170	9180	9190	9200	9210	9220	9230	9240	9250	9260	9270	9280	9290	9300	9310	9320	9330	9340	9350	9360	9370	9380	9390	9400	9410	9420	9430	9440	9450	9460	9470	9480	9490	9500	9510	9520	9530	9540	9550	9560	9570	9580	9590	9600	9610	9620	9630	9640	9650	9660	9670	9680	9690	9700	9710	9720	9730	9740	9750	9760	9770	9780	9790	9800	9810	9820	9830	9840	9850	9860	9870	9880	9890	9900	9910	9920	9930	9940	9950	9960	9970	9980	9990	10000	10010	10020	10030	10040	10050	10060	10070	10080	10090	10100	10110	10120	10130	10140	10150	10160	10170	10180	10190	10200	10210	10220	10230	10240	10250	10260	10270	10280	10290	10300	10310	10320	10330	10340	10350	10360	10370	10380	10390	10400	10410	10420	10430	10440	10450	10460	10470	10480	10490	10500	10510	10520	10530	10540	10550	10560	10570	10580	10590	10600	10610	10620	10630	10640	10650	10660	10670	10680	10690	10700	10710	10720	10730	10740	10750	10760	10770	10780	10790	10800	10810	10820	10830	10840	10850	10860	10870	10880	10890	10900	10910	10920	10930	10940	10950	10960	10970	10980	10990	11000	11010	11020	11030	11040	11050	11060	11070	11080	11090	11100	11110	11120	11130	11140	11150	11160	11170	11180	11190	11200	11210	11220	11230	11240	11250	11260	11270	11280	11290	11300	11310	11320	11330	11340	11350	11360	11370	11380	11390	11400	11410	11420	11430	11440	11450	11460	11470	11480	11490	11500	11510	11520	11530	11540	11550	11560	11570	11580	11590	11600	11610	11620	11630	11640	11650	11660	11670	11680	11690	11700	11710	11720	11730	11740	11750	11760	11770	11780	11790	11800	11810	11820	11830	11840	11850	11860	11870	11880	11890	11900	11910	11920	11930	11940	11950	11960	11970	11980	11990	12000	12010	12020	12030	12040	12050	12060	12070	12080	12090	12100	12110	12120	12130	12140	12150	12160	12170	12180	12190	12200	12210	12220	12230	12240	12250	12260	12270	12280	12290	12300	12310	12320	12330	12340	12350	12360	12370	12380	12390	12400	12410	12420	12430	12440	12450	12460	12470	12480	12490	12500	12510	12520	12530	12540	12550	12560	12570	12580	12590	12600	12610	12620	12630	12640	12650	12660	12670	12680	12690	12700	12710	12720	12730	12740	12750	12760	12770	12780	12790	12800	12810	12820	12830	12840	12850	12860	12870	12880	12890	12900	12910	12920	12930	12940	12950	12960	12970	12980	12990	13000	13010	13020	13030	13040	13050	13060	13070	13080	13090	13100	13110	13120	13130	13140	13150	13160	13170	13180	13190	13200	13210	13220	13230	13240	13250	13260	13270	13280	13290	13300	13310	13320	13330	13340	13350	13360	13370	13380	13390	13400	13410	13420	13430	13440	13450	13460	13470	13480	13490	13500	13510	13520	13530	13540	13550	13560	13570	13580	13590	13600	13610	13620	13630	13640	13650	13660	13670	13680	13690	13700	13710	13720	13730	13740	13750	13760	13770	13780	13790	13800	13810	13820	13830	13840	13850	13860	13870	13880	13890	13900	13910	13920	13930	13940	13950	13960	13970	13980	13990	14000	14010	14020	14030	14040	14050	14060	14070	14080	14090	14100	14110	14120	14130	14140	14150	14160	14170	14180	14190	14200	14210	14220	14230	14240	14250	14260	14270	14280	14290	14300	14310	14320	14330	14340	14350	14360	14370	14380	14390	14400	14410	14420	14430	14440	14450	14460	14470	14480	14490	14500	14510	14520	14530	14540	14550	14560	14570	14580	14590	14600	14610	14620	14630	14640	14650	14660	14670	14680	14690	14700	14710	14720	14730	14740	14750	14760	14770	14780	14790	14800	14810	14820	14830	14840	14850	14860	14870	14880	14890	14900	14910	14920	14930	14940	14950	14960	14970	14980	14990	15000	15010	15020	15030	15040	15050	15060	15070	15080	15090</
--------------------	------------------	----------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	---------

SAMPLE PROBLEM
 FLOOD PROOFING NEW DEVELOPMENT TO THE EXISTING
 100-YEAR FLOOD LEVEL
 DAMAGE REACH NO. 3
 DAMAGE REACH 3-LAST SECTION OF WEST FORK

EXHIBIT 4-4
 JANUARY 1979

LAND USE CATEGORIES											
WATER SURFACE ELEVATION	1	2	3	4	5	6	7	8	9	10	TOTAL
695.0	.60	0.	0.	0.	0.	0.	0.	0.	0.	0.	.60
696.0	.70	0.	0.	0.	0.	0.	0.	0.	0.	0.	.70
697.0	.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
698.0	.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
699.0	.80	0.	0.	0.	0.	0.	0.	0.	0.	0.	.80
700.0	.85	0.	0.	0.	0.	0.	0.	0.	0.	0.	.85
701.0	.90	0.	0.	0.	0.	0.	0.	0.	0.	0.	.90
702.0	.95	0.	0.	0.	0.	0.	0.	0.	0.	0.	.95
703.0	1.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.00
704.0	1.05	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.05
705.0	1.05	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.05
706.0	1.15	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.15
707.0	1.25	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.25
708.0	1.35	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.35
709.0	1.45	0.	0.	0.	0.	0.	0.	0.	.00	0.	1.45
710.0	1.60	0.	0.	0.	0.	0.	0.	0.	.02	0.	1.62
711.0	1.95	0.	0.	0.	0.	.01	0.	0.	.03	0.	1.99
711.9	2.10	0.	0.	0.	0.	.04	0.	0.	.06	0.	2.19
712.0	2.10	0.	0.	0.	130.10	.04	0.	0.	.06	0.	130.30
713.0	2.30	0.	0.	0.	176.64	.05	0.	0.	.07	0.	179.06
714.0	2.80	0.	0.	0.	207.24	.06	0.	0.	.09	0.	210.19
715.0	3.20	0.	0.	0.	223.32	.15	0.	0.	.15	0.	226.62
716.0	3.55	0.	0.	0.	295.44	.26	0.	0.	.19	0.	296.62

717.0	3.70	0.	0.	0.	0.	357.72	.29	0.	0.	0.	.23	0.	351.94
716.0	3.60	0.	0.	0.	0.	405.42	.33	0.	0.	0.	.27	0.	405.42
719.0	4.00	0.	0.	0.	0.	474.00	.36	0.	0.	0.	.33	0.	478.70
720.0	4.15	0.	0.	0.	0.	532.80	.39	0.	0.	0.	.42	0.	537.74
721.0	4.20	0.	0.	0.	0.	584.46	.41	0.	0.	0.	.47	0.	589.54
722.0	4.25	0.	0.	0.	0.	620.28	.41	0.	0.	0.	.54	0.	625.48
723.0	4.40	0.	0.	0.	0.	648.46	.41	0.	0.	0.	.59	0.	654.36
724.0	4.75	0.	0.	0.	0.	725.04	.43	0.	0.	0.	.65	0.	730.89
725.0	5.10	0.	0.	0.	0.	849.48	.50	0.	0.	0.	.75	0.	855.82
708.0	1.80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.80
710.2	1.60	0.	0.	0.	0.	0.	0.	0.	0.	0.	.02	0.	1.62
710.8	1.95	0.	0.	0.	0.	0.	0.	0.	0.	0.	.03	0.	1.98
711.3	2.05	0.	0.	0.	0.	0.	.03	0.	0.	0.	.08	0.	2.12
711.9	2.10	0.	0.	0.	0.	0.	.04	0.	0.	0.	.06	0.	2.19

DAMAGE CATEGORY	LAND USE CODE	LAND USE
1	1	NATURAL VEGETATION
2	2	DEVELOPED OPEN SPACE
3	3	LOW DENSITY HOUSING
4	4	MEDIUM DENSITY HOUSING
5	5	HIGH DENSITY HOUSING
6	6	AGRICULTURE
7	7	INDUSTRIAL
8	8	COMMERCIAL
9	9	PASTURE
10	10	WATER BODIES

EXHIBIT 4-5

SAMPLE PROBLEM

**REGULATING NEW DEVELOPMENT SUCH THAT THE ZERO STAGE
IS PLACED ABOVE THE EXISTING 100-YEAR FLOOD PLAIN**

SAMPLE PROBLEM
REGULATING NEW DEVELOPMENT SUCH THAT THE ZERO STAGE
IS PLACED ABOVE THE EXISTING 100-YEAR FLOOD PLAIN

Problem Statement

Assess the effect from implementation of a development policy that would require new residential housing, commercial and industrial land uses to be elevated such that zero stages are placed above the existing 100-year flood plain. (In this case the 100-year flood level for the existing or base land use pattern is assumed to be the same as the 100-year level for the 1990 land use pattern. If possible, the user should estimate flood levels for future conditions and input those levels when analyzing future alternatives). Request trace output for the medium density residential land use category in damage reach 1 and obtain damage values for the 2-year, 10-year, 20-year, 50-year and 100-year flood events. (Table 1 is a listing of the data base file used in the Trail Creek Watershed).

Description of Input Requirements

The key input data necessary for assessment of the above conditions are IPOL (J1.1) and the J4 card. The J8 card must be included to provide trace output. The policy water surface elevation is input on the DR cards and should correspond to the 100-year flood event level specified on the SE card.

The completed coding sheets have been included in this sample problem.

Discussion of Results

The trace information provides the user with a check of the computational procedure. In this case the first grid cell displayed reveals that the zero stage of land use 4 has been raised to an elevation of 627.1 feet (which

represents the 100-year flood level at the index location) as indicated by the values shown under the columns labeled "Damage Func. Stage" and "Damage Elev."

The note printed below the trace information indicates the total number of grid cells in damage reaches 1 and 3 that were raised to comply with the stated policy control.

In order to determine the impact of the above policy control the user should compare the damage values of the aggregated damage tables of Exhibits 4-2 and 4-5 (essentially the without and with conditions respectively).

TABLE 1
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1	1 2-92	GRID CELL ROW Row 1 Rows 2-92
2	1 2-129	GRID CELL COLUMN Colu 1 Columns 2-129
3	1	WATERSHED Trail Creek
5	1 2-5	DAMAGE REACH Damage reach 1 Damage reaches 2-5
10	1 2 3 4 5 6 7 8 9 10	EXISTING LAND USE Natural vegetation Developed open space Low density residential Medium density residential High density residential Agricultural Industrial Commercial Pasture Water bodies
11	1 2 3 4 5 6 7 8 9 10	1990 ALTERNATIVE LAND USE PATTERN Natural vegetation Developed open space Low density residential Medium density residential High density residential Agricultural Industrial Commercial Pasture Water bodies

TABLE 1 (continued)
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
13		REFERENCE FLOOD ELEVATION Flood elevations to the nearest .1 foot are stored for each grid cell in the flood plain
14		TOPOGRAPHIC ELEVATION Land elevations to the nearest .1 foot are stored for each grid cell in the study area

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELD)

PROJECT		SUBJECT		DATE		PAGE	
GENERAL		EXHIBIT 2-5		JANUARY 1979		1	
1	2	3	4	5	6	7	8
01	01	01	01	01	01	01	01
02	02	02	02	02	02	02	02
03	03	03	03	03	03	03	03
04	04	04	04	04	04	04	04
05	05	05	05	05	05	05	05
06	06	06	06	06	06	06	06
07	07	07	07	07	07	07	07
08	08	08	08	08	08	08	08
09	09	09	09	09	09	09	09
10	10	10	10	10	10	10	10
11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20
21	21	21	21	21	21	21	21
22	22	22	22	22	22	22	22
23	23	23	23	23	23	23	23
24	24	24	24	24	24	24	24
25	25	25	25	25	25	25	25
26	26	26	26	26	26	26	26
27	27	27	27	27	27	27	27
28	28	28	28	28	28	28	28
29	29	29	29	29	29	29	29
30	30	30	30	30	30	30	30
31	31	31	31	31	31	31	31
32	32	32	32	32	32	32	32
33	33	33	33	33	33	33	33
34	34	34	34	34	34	34	34
35	35	35	35	35	35	35	35
36	36	36	36	36	36	36	36
37	37	37	37	37	37	37	37
38	38	38	38	38	38	38	38
39	39	39	39	39	39	39	39
40	40	40	40	40	40	40	40
41	41	41	41	41	41	41	41
42	42	42	42	42	42	42	42
43	43	43	43	43	43	43	43
44	44	44	44	44	44	44	44
45	45	45	45	45	45	45	45
46	46	46	46	46	46	46	46
47	47	47	47	47	47	47	47
48	48	48	48	48	48	48	48
49	49	49	49	49	49	49	49
50	50	50	50	50	50	50	50
51	51	51	51	51	51	51	51
52	52	52	52	52	52	52	52
53	53	53	53	53	53	53	53
54	54	54	54	54	54	54	54
55	55	55	55	55	55	55	55
56	56	56	56	56	56	56	56
57	57	57	57	57	57	57	57
58	58	58	58	58	58	58	58
59	59	59	59	59	59	59	59
60	60	60	60	60	60	60	60
61	61	61	61	61	61	61	61
62	62	62	62	62	62	62	62
63	63	63	63	63	63	63	63
64	64	64	64	64	64	64	64
65	65	65	65	65	65	65	65
66	66	66	66	66	66	66	66
67	67	67	67	67	67	67	67
68	68	68	68	68	68	68	68
69	69	69	69	69	69	69	69
70	70	70	70	70	70	70	70
71	71	71	71	71	71	71	71
72	72	72	72	72	72	72	72
73	73	73	73	73	73	73	73
74	74	74	74	74	74	74	74
75	75	75	75	75	75	75	75
76	76	76	76	76	76	76	76
77	77	77	77	77	77	77	77
78	78	78	78	78	78	78	78
79	79	79	79	79	79	79	79
80	80	80	80	80	80	80	80
81	81	81	81	81	81	81	81
82	82	82	82	82	82	82	82
83	83	83	83	83	83	83	83
84	84	84	84	84	84	84	84
85	85	85	85	85	85	85	85
86	86	86	86	86	86	86	86
87	87	87	87	87	87	87	87
88	88	88	88	88	88	88	88
89	89	89	89	89	89	89	89
90	90	90	90	90	90	90	90
91	91	91	91	91	91	91	91
92	92	92	92	92	92	92	92
93	93	93	93	93	93	93	93
94	94	94	94	94	94	94	94
95	95	95	95	95	95	95	95
96	96	96	96	96	96	96	96
97	97	97	97	97	97	97	97
98	98	98	98	98	98	98	98
99	99	99	99	99	99	99	99
00	00	00	00	00	00	00	00

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELD)

TESTING		SAMPLE		ANALYSIS		RESULTS		REMARKS	
NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION
1	GENERAL	2	EXHIBIT 4-5	3	10000	4	10000	5	10000
6	10000	7	10000	8	10000	9	10000	10	10000
11	10000	12	10000	13	10000	14	10000	15	10000
16	10000	17	10000	18	10000	19	10000	20	10000
21	10000	22	10000	23	10000	24	10000	25	10000
26	10000	27	10000	28	10000	29	10000	30	10000
31	10000	32	10000	33	10000	34	10000	35	10000
36	10000	37	10000	38	10000	39	10000	40	10000
41	10000	42	10000	43	10000	44	10000	45	10000
46	10000	47	10000	48	10000	49	10000	50	10000
51	10000	52	10000	53	10000	54	10000	55	10000
56	10000	57	10000	58	10000	59	10000	60	10000
61	10000	62	10000	63	10000	64	10000	65	10000
66	10000	67	10000	68	10000	69	10000	70	10000
71	10000	72	10000	73	10000	74	10000	75	10000
76	10000	77	10000	78	10000	79	10000	80	10000
81	10000	82	10000	83	10000	84	10000	85	10000
86	10000	87	10000	88	10000	89	10000	90	10000
91	10000	92	10000	93	10000	94	10000	95	10000
96	10000	97	10000	98	10000	99	10000	100	10000

NUMBER	DATE	CLASS	TIME	INSTRUCTOR	STUDENT	GRADE	REMARKS	DATE	TIME	INSTRUCTOR	STUDENT	GRADE	REMARKS
1	1917	1	1	1	1	1	1	1	1	1	1	1	1
2	1917	1	1	1	1	1	1	1	1	1	1	1	1
3	1917	1	1	1	1	1	1	1	1	1	1	1	1
4	1917	1	1	1	1	1	1	1	1	1	1	1	1
5	1917	1	1	1	1	1	1	1	1	1	1	1	1
6	1917	1	1	1	1	1	1	1	1	1	1	1	1
7	1917	1	1	1	1	1	1	1	1	1	1	1	1
8	1917	1	1	1	1	1	1	1	1	1	1	1	1
9	1917	1	1	1	1	1	1	1	1	1	1	1	1
10	1917	1	1	1	1	1	1	1	1	1	1	1	1
11	1917	1	1	1	1	1	1	1	1	1	1	1	1
12	1917	1	1	1	1	1	1	1	1	1	1	1	1
13	1917	1	1	1	1	1	1	1	1	1	1	1	1
14	1917	1	1	1	1	1	1	1	1	1	1	1	1
15	1917	1	1	1	1	1	1	1	1	1	1	1	1
16	1917	1	1	1	1	1	1	1	1	1	1	1	1
17	1917	1	1	1	1	1	1	1	1	1	1	1	1
18	1917	1	1	1	1	1	1	1	1	1	1	1	1
19	1917	1	1	1	1	1	1	1	1	1	1	1	1
20	1917	1	1	1	1	1	1	1	1	1	1	1	1
21	1917	1	1	1	1	1	1	1	1	1	1	1	1
22	1917	1	1	1	1	1	1	1	1	1	1	1	1
23	1917	1	1	1	1	1	1	1	1	1	1	1	1
24	1917	1	1	1	1	1	1	1	1	1	1	1	1
25	1917	1	1	1	1	1	1	1	1	1	1	1	1
26	1917	1	1	1	1	1	1	1	1	1	1	1	1
27	1917	1	1	1	1	1	1	1	1	1	1	1	1
28	1917	1	1	1	1	1	1	1	1	1	1	1	1
29	1917	1	1	1	1	1	1	1	1	1	1	1	1
30	1917	1	1	1	1	1	1	1	1	1	1	1	1
31	1917	1	1	1	1	1	1	1	1	1	1	1	1
32	1917	1	1	1	1	1	1	1	1	1	1	1	1
33	1917	1	1	1	1	1	1	1	1	1	1	1	1
34	1917	1	1	1	1	1	1	1	1	1	1	1	1
35	1917	1	1	1	1	1	1	1	1	1	1	1	1
36	1917	1	1	1	1	1	1	1	1	1	1	1	1
37	1917	1	1	1	1	1							

[illegible]

SAMPLE PROBLEM
REGULATING NEW DEVELOPMENT SUCH THAT THE ZERO STAGE IS
PLACED ABOVE THE EXISTING 100-YEAR FLOOD PLAIN JANUARY 1979
EXHIBIT 40-5

ALL CARD

CC 123456789012345678901234567890123456789012345678901234567890

TOTAL = 0 0 0 1 0 5 0
2, SPECIFIED NEW DEVELOPMENT WILL HAVE THEIR GROUND FLOOR PLACED ABOVE A POLICY LEVEL

PROF. O. YMERI IS NOW FLOOD PROOFING IN THIS RUN

REVAC - 0. THERE IS NO PERMANENT EVACUATION IN THIS QUA

REFUGEE = 0, YWERE TO NO PERMANENT EVACUATION IN THIS WAR

1980 0. NORMAL PRIORITY

STANDARD - 1. 2000 10000 100000 1000000

ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED EXCEPT WHERE SHOWN OTHERWISE

1. The number of days of delay caused by the accident is 10 days.

Q. AN AGGREGATION OF SINGLE EVENT DAMAGES

0444 25

CC 12345678901234567890123456789012345678901234567890

CC 12345678901234567890123456789012345678901234567890

21 10 1 1 21

DATA HAVE BEEN SUPPLIED

PROFILE = 1, THE DATA BASE IS ON THIS COMPUTER UNIT

45007 1. THE DATA BASE IS SUMMARY

10. THE NUMBER OF DAYS VARIATION

YES - 92. THE NUMBER OF HOURS IN THE JAYA SANG

129 THE NUMBER OF COLUMNS IN THE DATA BASE

1
 2
 3
 4
 5
 6
 7
 8
 9
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23
 24
 25
 26
 27
 28
 29
 30
 31
 32
 33
 34
 35
 36
 37
 38
 39
 40
 41
 42
 43
 44
 45
 46
 47
 48
 49
 50
 51
 52
 53
 54
 55
 56
 57
 58
 59
 60
 61
 62
 63
 64
 65
 66
 67
 68
 69
 70
 71
 72
 73
 74
 75
 76
 77
 78
 79
 80
 81
 82
 83
 84
 85
 86
 87
 88
 89
 90
 91
 92
 93
 94
 95
 96
 97
 98
 99
 100
 101
 102
 103
 104
 105
 106
 107
 108
 109
 110
 111
 112
 113
 114
 115
 116
 117
 118
 119
 120
 121
 122
 123
 124
 125
 126
 127
 128
 129
 130
 131
 132
 133
 134
 135
 136
 137
 138
 139
 140
 141
 142
 143
 144
 145
 146
 147
 148
 149
 150
 151
 152
 153
 154
 155
 156
 157
 158
 159
 160
 161
 162
 163
 164
 165
 166
 167
 168
 169
 170
 171
 172
 173
 174
 175
 176
 177
 178
 179
 180
 181
 182
 183
 184
 185
 186
 187
 188
 189
 190
 191
 192
 193
 194
 195
 196
 197
 198
 199
 200
 201
 202
 203
 204
 205
 206
 207
 208
 209
 210
 211
 212
 213
 214
 215
 216
 217
 218
 219
 220
 221
 222
 223
 224
 225
 226
 227
 228
 229
 230
 231
 232
 233
 234
 235
 236
 237
 238
 239
 240
 241
 242
 243
 244
 245
 246
 247
 248
 249
 250
 251
 252
 253
 254
 255
 256
 257
 258
 259
 260
 261
 262
 263
 264
 265
 266
 267
 268
 269
 270
 271
 272
 273
 274
 275
 276
 277
 278
 279
 280
 281
 282
 283
 284
 285
 286
 287
 288
 289
 290
 291
 292
 293
 294
 295
 296
 297
 298
 299
 300
 301
 302
 303
 304
 305
 306
 307
 308
 309
 310
 311
 312
 313
 314
 315
 316
 317
 318
 319
 320
 321
 322
 323
 324
 325
 326
 327
 328
 329
 330
 331
 332
 333
 334
 335
 336
 337
 338
 339
 340
 341
 342
 343
 344
 345
 346
 347
 348
 349
 350
 351
 352
 353
 354
 355
 356
 357
 358
 359
 360
 361
 362
 363
 364
 365
 366
 367
 368
 369
 370
 371
 372
 373
 374
 375
 376
 377
 378
 379
 380
 381
 382
 383
 384
 385
 386
 387
 388
 389
 390
 391
 392
 393
 394
 395
 396
 397
 398
 399
 400
 401
 402
 403
 404
 405
 406
 407
 408
 409
 410
 411
 412
 413
 414
 415
 416
 417
 418
 419
 420
 421
 422
 423
 424
 425
 426
 427
 428
 429
 430
 431
 432
 433
 434
 435
 436
 437
 438
 439
 440
 441
 442
 443
 444
 445
 446
 447
 448
 449
 450
 451
 452
 453
 454
 455
 456
 457
 458
 459
 460
 461
 462
 463
 464
 465
 466
 467
 468
 469
 470
 471
 472
 473
 474
 475
 476
 477
 478
 479
 480
 481
 482
 483
 484
 485
 486
 487
 488
 489
 490
 491
 492
 493
 494
 495
 496
 497
 498
 499
 500
 501
 502
 503
 504
 505
 506
 507
 508
 509
 510
 511
 512
 513
 514
 515
 516
 517
 518
 519
 520
 521
 522
 523
 524
 525

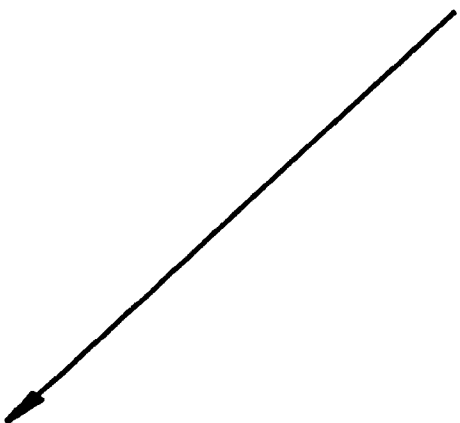
J3 CARD
 CC 123456789012345678901234567890123456789012345678901234567890
 33 3 2 11 10 14 13 31

DATA VARIABLE INFORMATION
 =====
 TOAMRC = 5, THE DATA VARIABLE THAT IS THE DAMAGE REACH CODE
 MUOR = 2, THE NUMBER OF DAMAGE REACHES IN THIS ANALYSIS
 ILAND = 11, THE DATA VARIABLE THAT IS THE LAND USE ANALYZED
 TRAGE = 10, THE DATA VARIABLE CONSIDERED THE BASE CONDITION
 MOLIIC = 10, THE NUMBER OF LAND USE CATEGORIES
 ITOPO = 14, THE DATA VARIABLE THAT IS TOPOGRAPHY
 ITRPD = 13, THE DATA VARIABLE THAT IS THE REFERENCE FLOOD ELEVATION
 IELV = 31, THE NUMBER OF ELEVATION-DAMAGE POINTS TO BE CALCULATED

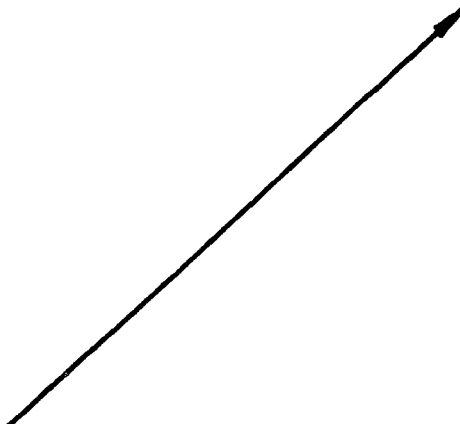
J4 CARD(12)
 CC 123456789012345678901234567890123456789012345678901234567890
 34 3 4 5 7 4
 THE FOLLOWING LAND USE CATEGORIES
 ARE SUBJECT TO POLICY CONTROLS
 =====

J4 CARD(1)
 CC 123456789012345678901234567890123456789012345678901234567890
 34 1 4
 TRACE INFORMATION
 =====
 NIDM = 1, TRACE OUTPUT PROVIDED IN THIS DAMAGE REACH
 VILL = 4, TRACE OUTPUT PROVIDED FOR THIS LAND USE CATEGORY

J4 CARD
 CC 123456789012345678901234567890123456789012345678901234567890
 34 1 4 2 2 2 0 1
 SUMMARY CARD
 =====



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



SAMPLE PROBLEM
 REGULATING NEW DEVELOPMENT SUCH THAT THE ZERO STAGE IS
 PLACED ABOVE THE EXISTING 100-YEAR FLOOD PLAIN JANUARY 1979

LAND USE CATEGORY NO. 4

MEDIUM DENSITY HOUSING

DEPTH OF WATER	PERCENT DAMAGE STRUCTURES	PERCENT DAMAGE CONTENTS	PERCENT DAMAGE OTHER	AMOUNT OF DAMAGE PER GRID CELL IN THOUSAND DOLLARS
0.00	0.00	0.00	0.00	0.00
0.25	0.00	0.00	0.00	0.00
0.50	0.00	0.00	0.00	0.00
0.75	0.00	0.00	0.00	0.00
1.00	0.00	0.00	0.00	0.00
1.25	0.00	0.00	0.00	0.00
1.50	0.00	0.00	0.00	0.00
1.75	0.00	0.00	0.00	0.00
2.00	0.00	0.00	0.00	0.00
2.25	0.00	0.00	0.00	0.00
2.50	0.00	0.00	0.00	0.00
2.75	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00
3.50	0.00	0.00	0.00	0.00
3.75	0.00	0.00	0.00	0.00
4.00	0.00	0.00	0.00	0.00
4.25	0.00	0.00	0.00	0.00
4.50	0.00	0.00	0.00	0.00
4.75	0.00	0.00	0.00	0.00
5.00	0.00	0.00	0.00	0.00
5.25	0.00	0.00	0.00	0.00
5.50	0.00	0.00	0.00	0.00
5.75	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.00	0.00
6.25	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00
6.75	0.00	0.00	0.00	0.00
7.00	0.00	0.00	0.00	0.00
7.25	0.00	0.00	0.00	0.00
7.50	0.00	0.00	0.00	0.00
7.75	0.00	0.00	0.00	0.00
8.00	0.00	0.00	0.00	0.00
8.25	0.00	0.00	0.00	0.00
8.50	0.00	0.00	0.00	0.00
8.75	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.00	0.00
9.25	0.00	0.00	0.00	0.00
9.50	0.00	0.00	0.00	0.00
9.75	0.00	0.00	0.00	0.00
10.00	0.00	0.00	0.00	0.00
10.25	0.00	0.00	0.00	0.00
10.50	0.00	0.00	0.00	0.00
10.75	0.00	0.00	0.00	0.00
11.00	0.00	0.00	0.00	0.00
11.25	0.00	0.00	0.00	0.00
11.50	0.00	0.00	0.00	0.00
11.75	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.00	0.00
12.25	0.00	0.00	0.00	0.00
12.50	0.00	0.00	0.00	0.00
12.75	0.00	0.00	0.00	0.00
13.00	0.00	0.00	0.00	0.00
13.25	0.00	0.00	0.00	0.00
13.50	0.00	0.00	0.00	0.00
13.75	0.00	0.00	0.00	0.00
14.00	0.00	0.00	0.00	0.00
14.25	0.00	0.00	0.00	0.00
14.50	0.00	0.00	0.00	0.00
14.75	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.00	0.00
15.25	0.00	0.00	0.00	0.00
15.50	0.00	0.00	0.00	0.00
15.75	0.00	0.00	0.00	0.00
16.00	0.00	0.00	0.00	0.00
16.25	0.00	0.00	0.00	0.00
16.50	0.00	0.00	0.00	0.00
16.75	0.00	0.00	0.00	0.00
17.00	0.00	0.00	0.00	0.00
17.25	0.00	0.00	0.00	0.00
17.50	0.00	0.00	0.00	0.00
17.75	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.00	0.00
18.25	0.00	0.00	0.00	0.00
18.50	0.00	0.00	0.00	0.00
18.75	0.00	0.00	0.00	0.00
19.00	0.00	0.00	0.00	0.00
19.25	0.00	0.00	0.00	0.00
19.50	0.00	0.00	0.00	0.00
19.75	0.00	0.00	0.00	0.00
20.00	0.00	0.00	0.00	0.00

DENSITY OF THE LAND USE UNITS PER GRID CELL = 4.00

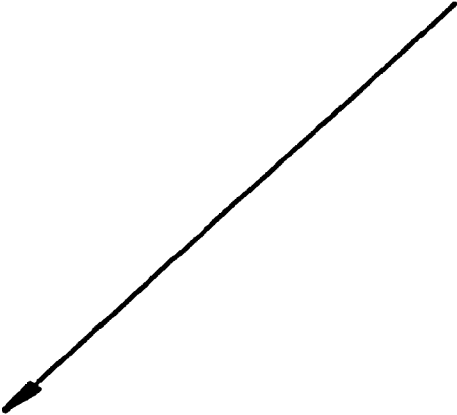
BASE VALUE OF THE STRUCTURE = 10000.00

BASE VALUE OF THE CONTENTS (30.00 PERCENT OF THE STRUCTURE VALUE) = 3000.00

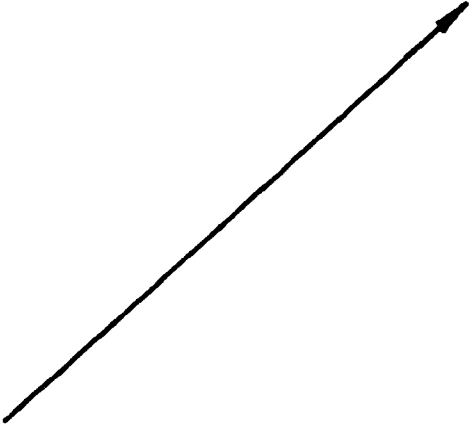
BASE VALUE OF OTHER = 0.00

VACANCY FACTOR (PERCENT DEVELOPED) = 70.0

ONLY NEW DEVELOPMENT WITH THIS LAND USE WILL BE RAISED TO THE GROUND FLOOR IS ABOVE A SPECIFIED LEVEL



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



SAMPLE PROBLEM
 REGULATING NEW DEVELOPMENT SUCH THAT THE ZERO STAGE IS
 PLACED ABOVE THE EXISTING 100-YEAR FLOOD PLAIN JANUARY 1979

EXHIBIT 4-5

DAMAGE REACH INDEX LOCATION SUMMARY

ID. NO.	REFERENCE FLOOD ELEVATION	POLICY FLOOD ELEVATION	FLOOD PROOFING ELEVATION	EVACUATION ELEVATION	STARTING DAMAGE ELEVATION	DAMAGE ELEVATION INCREMENT	AGGREGATED DAMAGE RCH. ID.	MODIFY LAND USE DENSITY
1.	634.0	627.1	0.	0.	610.0	1.00	0	0
3.	714.0	711.9	0.	0.	695.0	1.00	0	0

SINGLE EVENTS FOR DAMAGE REACHES

DAMAGE REACH NO.	2 YEAR EVENT	10 YEAR EVENT	50 YEAR EVENT	100 YEAR EVENT
1.	616.7	623.9	624.0	627.1
3.	709.4	710.2	711.3	711.9

DAMAGE REACH 1 IS BEING TRACED FOR LAND USE

* INDICATES ELEVATION IS AT GRID CELL

FROM	COL	ARRAY BASE	ALT.	REF.	POLICY	STOPD	STOPD	FLOOD	SWAC	DAMAGE	DAMAGE	ACCUM
				FLOOD	ELEV.	BEFORE	IN FLOOD	ELEV.	ELEV.	FEET	ELEV.	DAMAGE
80	7	14	2	4	413.10	600.00	413.10	0	0	-2.10	623.00	0.
80	7	14	2	4	420.00	600.00	413.10	0	0	-1.10	623.00	0.
80	7	16	2	4	420.00	600.00	413.10	0	0	-1.10	623.00	2.58
80	7	16	2	4	420.00	600.00	413.10	0	0	-1.10	623.00	2.58
80	7	19	2	4	420.00	600.00	413.10	0	0	0.00	623.00	2.71
80	7	20	2	4	420.00	600.00	413.10	0	0	0.00	623.00	2.71
80	7	21	2	4	420.00	600.00	413.10	0	0	0.00	623.00	11.44
80	7	21	2	4	420.00	600.00	413.10	0	0	0.00	623.00	11.44
80	7	22	2	4	420.00	600.00	413.10	0	0	0.00	623.00	12.55
80	7	23	2	4	420.00	600.00	413.10	0	0	0.00	623.00	12.55
80	7	23	2	4	420.00	600.00	413.10	0	0	0.00	623.00	13.71
80	7	24	2	4	420.00	600.00	413.10	0	0	0.00	623.00	13.71
80	7	24	2	4	420.00	600.00	413.10	0	0	0.00	623.00	14.40
80	7	25	2	4	420.00	600.00	413.10	0	0	0.00	623.00	14.40
80	7	26	2	4	420.00	600.00	413.10	0	0	0.00	623.00	14.40
80	7	27	2	4	420.00	600.00	413.10	0	0	0.00	623.00	13.69
80	7	28	2	4	420.00	600.00	413.10	0	0	0.00	623.00	13.69
80	7	28	2	4	420.00	600.00	413.10	0	0	0.00	623.00	16.17
80	7	29	2	4	420.00	600.00	413.10	0	0	0.00	623.00	16.17
80	7	30	2	4	420.00	600.00	413.10	0	0	0.00	623.00	17.50
80	7	31	2	4	420.00	600.00	413.10	0	0	0.00	623.00	17.50
80	6	21	2	4	420.00	620.00	420.00	0	0	13.00	631.00	17.42
80	6	21	2	4	420.00	620.00	420.00	0	0	13.00	631.00	17.42
80	4	23	2	4	420.00	620.00	420.00	0	0	13.00	631.00	17.42
80	4	23	2	4	420.00	620.00	420.00	0	0	13.00	631.00	17.42
80	8	24	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	24	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	25	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	25	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	26	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	27	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	27	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	28	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	28	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	29	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	30	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	31	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55
80	8	31	2	4	420.00	620.00	420.00	0	0	13.00	631.00	12.55

DAMAGE BEACH 1 HAS 9. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS
DAMAGE BEACH 3 HAS 1. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS
DAMAGE BEACH 5 HAS 1. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS

DAMAGE REACH 3 HAS 12. CELLS WITH DAMAGES STARTING BELOW THE STARTING AGGREGATION ELEVATION

DAMAGE REACH	I WAS 100.	CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION
DAMAGE REACH	3 WAS 137.	CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION

EXHIBIT 4-5
 SAMPLE PROBLEM
 REGULATING NEW DEVELOPMENT SUCH THAT THE ZERO STAGE IS
 PLACED ABOVE THE EXISTING 100-YEAR FLOOD PLAIN JANUARY 1979
 DAMAGE REACH NO. 1
 DAMAGE REACH 1-OCCLUDE TO COMPLUENCE

WATER SURFACE ELEVATION	LAND USE CATEGORIES										TOTAL
	1	2	3	4	5	6	7	8	9	10	
610.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
611.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
612.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
613.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
614.0	.13	0.	0.	0.	0.	0.	0.	0.	0.	0.	.13
615.0	.13	0.	0.	0.	0.	0.	0.	0.	.07	0.	.20
616.0	.13	0.	0.	0.	0.	0.	0.	0.	.10	0.	.23
617.0	.20	0.	0.	0.	0.	0.	0.	0.	.12	0.	.32
618.0	.25	0.	0.	0.	0.	0.	0.	0.	.15	0.	.40
619.0	.23	0.	0.	0.	0.	0.	0.	0.	.18	0.	.43
620.0	.35	0.	0.	0.	0.	0.	0.	0.	.23	0.	.58
621.0	.40	0.	0.	0.	0.	0.	0.	0.	.27	0.	.67
622.0	.43	0.	0.	0.	0.	0.	0.	0.	.29	0.	.72
623.0	.45	0.	0.	0.	0.	0.	0.	0.	.31	0.	.76
624.0	.50	.30	0.	0.	0.	0.	0.	0.	.33	0.	1.13
625.0	.55	.30	0.	0.	0.	0.	0.	0.	.39	0.	1.24
626.0	.55	.30	0.	.33	0.	0.	0.	0.	.41	0.	1.23
627.0	.70	.30	0.	2.48	0.	0.	142.14	0.	.43	0.	146.04
627.1	.70	.40	0.	2.49	0.	0.	150.88	0.	.43	0.	151.10
628.0	.80	.40	0.	3.31	0.	0.	320.47	0.	.46	0.	335.44
629.0	.90	.40	0.	8.72	0.	0.	753.43	6.40	.49	0.	770.34
630.0	1.10	.40	0.	11.34	0.	0.	908.88	19.46	.52	0.	941.30
631.0	1.15	.40	0.	12.35	0.	0.	1036.19	32.51	.55	0.	1101.35

DAMAGE CATEGORY	LAND USE CODE	LAND USE	1	2	3	4	5	6	7	8	9	10
1	1	NATURAL VEGETATION	1277.07	1396.00	1498.32	1821.02	2037.04	2246.01	2436.89	2537.74	2585.12	
2	2	DEVELOPED OPEN SPACE	45.27	50.62	71.68	216.32	325.36	426.24	472.32	509.13	541.25	
3	3	LOW DENSITY HOUSING	0.	0.	0.	0.	0.	0.	0.	0.	0.	
4	4	MEDIUM DENSITY HOUSING	0.	0.	0.	0.	0.	0.	0.	0.	0.	
5	5	HIGH DENSITY HOUSING	0.	0.	0.	0.	0.	0.	0.	0.	0.	
6	6	AGRICULTURE	0.	0.	0.	0.	0.	0.	0.	0.	0.	
7	7	INDUSTRIAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	
8	8	COMMERCIAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	
9	9	PASTURE	0.	0.	0.	0.	0.	0.	0.	0.	0.	
10	10	WATER BODIES	0.	0.	0.	0.	0.	0.	0.	0.	0.	
11	11		0.	0.	0.	0.	0.	0.	0.	0.	0.	
12	12		0.	0.	0.	0.	0.	0.	0.	0.	0.	
13	13		0.	0.	0.	0.	0.	0.	0.	0.	0.	
14	14		0.	0.	0.	0.	0.	0.	0.	0.	0.	
15	15		0.	0.	0.	0.	0.	0.	0.	0.	0.	
16	16		0.	0.	0.	0.	0.	0.	0.	0.	0.	
17	17		0.	0.	0.	0.	0.	0.	0.	0.	0.	
18	18		0.	0.	0.	0.	0.	0.	0.	0.	0.	
19	19		0.	0.	0.	0.	0.	0.	0.	0.	0.	
20	20		0.	0.	0.	0.	0.	0.	0.	0.	0.	
21	21		0.	0.	0.	0.	0.	0.	0.	0.	0.	
22	22		0.	0.	0.	0.	0.	0.	0.	0.	0.	
23	23		0.	0.	0.	0.	0.	0.	0.	0.	0.	
24	24		0.	0.	0.	0.	0.	0.	0.	0.	0.	
25	25		0.	0.	0.	0.	0.	0.	0.	0.	0.	
26	26		0.	0.	0.	0.	0.	0.	0.	0.	0.	
27	27		0.	0.	0.	0.	0.	0.	0.	0.	0.	
28	28		0.	0.	0.	0.	0.	0.	0.	0.	0.	
29	29		0.	0.	0.	0.	0.	0.	0.	0.	0.	
30	30		0.	0.	0.	0.	0.	0.	0.	0.	0.	
31	31		0.	0.	0.	0.	0.	0.	0.	0.	0.	
32	32		0.	0.	0.	0.	0.	0.	0.	0.	0.	
33	33		0.	0.	0.	0.	0.	0.	0.	0.	0.	
34	34		0.	0.	0.	0.	0.	0.	0.	0.	0.	
35	35		0.	0.	0.	0.	0.	0.	0.	0.	0.	
36	36		0.	0.	0.	0.	0.	0.	0.	0.	0.	
37	37		0.	0.	0.	0.	0.	0.	0.	0.	0.	
38	38		0.	0.	0.	0.	0.	0.	0.	0.	0.	
39	39		0.	0.	0.	0.	0.	0.	0.	0.	0.	
40	40		0.	0.	0.	0.	0.	0.	0.	0.	0.	
41	41		0.	0.	0.	0.	0.	0.	0.	0.	0.	
42	42		0.	0.	0.	0.	0.	0.	0.	0.	0.	
43	43		0.	0.	0.	0.	0.	0.	0.	0.	0.	
44	44		0.	0.	0.	0.	0.	0.	0.	0.	0.	
45	45		0.	0.	0.	0.	0.	0.	0.	0.	0.	
46	46		0.	0.	0.	0.	0.	0.	0.	0.	0.	
47	47		0.	0.	0.	0.	0.	0.	0.	0.	0.	
48	48		0.	0.	0.	0.	0.	0.	0.	0.	0.	
49	49		0.	0.	0.	0.	0.	0.	0.	0.	0.	
50	50		0.	0.	0.	0.	0.	0.	0.	0.	0.	
51	51		0.	0.	0.	0.	0.	0.	0.	0.	0.	
52	52		0.	0.	0.	0.	0.	0.	0.	0.	0.	
53	53		0.	0.	0.	0.	0.	0.	0.	0.	0.	
54	54		0.	0.	0.	0.	0.	0.	0.	0.	0.	
55	55		0.	0.	0.	0.	0.	0.	0.	0.	0.	
56	56		0.	0.	0.	0.	0.	0.	0.	0.	0.	
57	57		0.	0.	0.	0.	0.	0.	0.	0.	0.	
58	58		0.	0.	0.	0.	0.	0.	0.	0.	0.	
59	59		0.	0.	0.	0.	0.	0.	0.	0.	0.	
60	60		0.	0.	0.	0.	0.	0.	0.	0.	0.	
61	61		0.	0.	0.	0.	0.	0.	0.	0.	0.	
62	62		0.	0.	0.	0.	0.	0.	0.	0.	0.	
63	63		0.	0.	0.	0.	0.	0.	0.	0.	0.	
64	64		0.	0.	0.	0.	0.	0.	0.	0.	0.	
65	65		0.	0.	0.	0.	0.	0.	0.	0.	0.	
66	66		0.	0.	0.	0.	0.	0.	0.	0.	0.	
67	67		0.	0.	0.	0.	0.	0.	0.	0.	0.	
68	68		0.	0.	0.	0.	0.	0.	0.	0.	0.	
69	69		0.	0.	0.	0.	0.	0.	0.	0.	0.	
70	70		0.	0.	0.	0.	0.	0.	0.	0.	0.	
71	71		0.	0.	0.	0.	0.	0.	0.	0.	0.	
72	72		0.	0.	0.	0.	0.	0.	0.	0.	0.	
73	73		0.	0.	0.	0.	0.	0.	0.	0.	0.	
74	74		0.	0.	0.	0.	0.	0.	0.	0.	0.	
75	75		0.	0.	0.	0.	0.	0.	0.	0.	0.	
76	76		0.	0.	0.	0.	0.	0.	0.	0.	0.	
77	77		0.	0.	0.	0.	0.	0.	0.	0.	0.	
78	78		0.	0.	0.	0.	0.	0.	0.	0.	0.	
79	79		0.	0.	0.	0.	0.	0.	0.	0.	0.	
80	80		0.	0.	0.	0.	0.	0.	0.	0.	0.	
81	81		0.	0.	0.	0.	0.	0.	0.	0.	0.	
82	82		0.	0.	0.	0.	0.	0.	0.	0.	0.	
83	83		0.	0.	0.	0.	0.	0.	0.	0.	0.	
84	84		0.	0.	0.	0.	0.	0.	0.	0.	0.	
85	85		0.	0.	0.	0.	0.	0.	0.	0.	0.	
86	86		0.	0.	0.	0.	0.	0.	0.	0.	0.	
87	87		0.	0.	0.	0.	0.	0.	0.	0.	0.	
88	88		0.	0.	0.	0.	0.	0.	0.	0.	0.	
89	89		0.	0.	0.	0.	0.	0.	0.	0.	0.	
90	90		0.	0.	0.	0.	0.	0.	0.	0.	0.	
91	91		0.	0.	0.	0.	0.	0.	0.	0.	0.	
92	92		0.	0.	0.	0.	0.	0.	0.	0.	0.	
93	93		0.	0.	0.	0.	0.	0.	0.	0.	0.	
94	94		0.	0.	0.	0.	0.	0.	0.	0.	0.	
95	95		0.	0.	0.	0.	0.	0.	0.	0.	0.	
96	96		0.	0.	0.	0.	0.	0.	0.	0.	0.	
97	97		0.	0.	0.	0.	0.	0.	0.	0.	0.	
98	98		0.	0.	0.	0.	0.	0.	0.	0.	0.	
99	99		0.	0.	0.	0.	0.	0.	0.	0.	0.	
100	100		0.	0.	0.	0.	0.	0.	0.	0.	0.	

SAMPLE PROBLEM
 REGULATING RE-DEVELOPMENT SUCH THAT THE 1980 STAGE IS
 PLACED DAMAGED DURING 1980-1981 FLOOD PLAIN JANUARY 1970
 DAMAGE REACH NO. 3

DAMAGE REACH 3-LAST SECTION OF BEST FURN

STATION NUMBER ELEVATION	LAND USE CATEGORIES										TOTAL
	1	2	3	4	5	6	7	8	9	10	
685.0	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	.40
686.0	.70	0.	0.	0.	0.	0.	0.	0.	0.	0.	.70
687.0	.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
688.0	.75	0.	0.	0.	0.	0.	0.	0.	0.	0.	.75
689.0	.40	0.	0.	0.	0.	0.	0.	0.	0.	0.	.40
700.0	.65	0.	0.	0.	0.	0.	0.	0.	0.	0.	.65
701.0	.90	0.	0.	0.	0.	0.	0.	0.	0.	0.	.90
702.0	.95	0.	0.	0.	0.	0.	0.	0.	0.	0.	.95
703.0	1.00	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.00
704.0	1.05	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.05
705.0	1.05	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.05
706.0	1.15	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.15
707.0	1.25	0.	0.	0.	15.40	0.	0.	0.	0.	0.	16.65
708.0	1.35	0.	0.	0.	15.78	0.	0.	0.	0.	0.	17.13
709.0	1.45	0.	0.	0.	17.40	0.	0.	0.	0.	0.	18.85
710.0	1.40	0.	0.	0.	17.40	0.	0.	0.	0.	0.	18.80
711.0	1.95	0.	0.	0.	33.00	.01	0.	0.	0.	0.	34.96
711.8	2.10	0.	0.	0.	34.08	.04	0.	0.	0.	0.	36.22
712.0	2.10	0.	0.	0.	42.42	.04	0.	0.	0.	0.	44.46
713.0	2.30	0.	0.	0.	120.96	.03	0.	0.	0.	0.	123.29
714.0	2.40	0.	0.	0.	145.46	.04	0.	0.	0.	0.	147.90
715.0	3.20	0.	0.	0.	200.76	.13	0.	0.	0.	0.	201.89
716.0	3.55	0.	0.	0.	279.10	.24	0.	0.	0.	0.	282.89

[illegible]

EXHIBIT 4-6

SAMPLE PROBLEM

**UTILIZING FLOOD PLAIN REGULATION, FLOOD PROOFING
AND EVACUATION**

SAMPLE PROBLEM
UTILIZING FLOOD PLAIN REGULATION,
FLOOD PROOFING AND EVACUATION

Problem Statement

Determine the modified damages that would occur with the implementation of the following:

- a policy control that would elevate the zero stage of new development in residential housing to the 100-year flood event level
- flood proofing of new development in residential housing to the 100-year flood level (target protection level)
- permanent evacuation of new development classified as commercial or industrial from the 20-year flood plain
- and modification of evacuated areas into open-developed land uses.

In addition request trace output for the medium density residential land use category in damage reach 1. (Table 1 is a listing of the data base file used in the Trail Creek Watershed).

Description of Input Requirements

The input value, IPOL (J1.1), designates the general type of policy control and IPROF (J1.2) specifies the type of flood proofing option requested. The evacuation of specified new development is indicated by IEVAC (J1.3) and modification of evacuated land use areas indicated by IEVCLU (J1.4). The J4, J5 and J7 cards define the land use categories to be regulated or protected by policy control, flood proofing and evacuation.

Discussion of Results

Although the stage-damage function for each land use category is not shown in this sample problem, it should be noted that a brief description of the damage reduction measure (s) affecting each land use category is printed at the bottom of the appropriate stage-damage function. As shown by the information printed below the input stage-damage functions for land use categories 4 and 7 (pages 14 and 16), medium density housing is affected by policy control and flood proofing options and industrial is affected by evacuation.

The index location water surface elevations (for the damage reaches analyzed) governing each of the damage reduction options are tabulated in the "Damage Reach Index Location Summary" page 18. The 100-year flood event levels (at the index locations) appear under "Policy Flood Elevation" and "Flood Proofing Elevation" whereas the 20-year flood event levels appear under "Evacuation Elevation" (as input by the user on the DR cards). The regulating flood event levels should be identical to the corresponding levels printed for the single events (page 18 also).

A comparison of the trace information of Exhibits 4-5 and 4-6 provides the user with a check on the computational procedures involved. Since the first grid cell traced in Exhibit 4-5 represents a policy control identical to the one used in this sample problem, the elevation-damage relationships should be the same above the 100-year water surface elevation (627.1 feet). The printed information at the bottom of page 19 indicates the total number of grid cells affected by the damage reduction measures utilized.

An inspection of the aggregated damage tables for damage reaches 1 and 3 should reveal the following:

- grid cells classified as land use categories 3, 4 and 5 (residential housing) should show no damage up through the 100-year flood event elevation at the index location

- since eight grid cells in damage reach 1 were evacuated and modified to developed open space, the aggregated damage values (damage reach 1) under land use 2 should reflect an increase corresponding to additional grid cells up to a maximum of 8 (at an elevation of 640 feet the aggregated damage is \$1,800 for land use 2 which is an increase of \$800 over the \$1,000 shown for the corresponding damage of Exhibit 4-2 this \$800 increase represents 8 grid cells of developed open space).

As in the preceding sample problems the user can compare the impact of the various damage reduction options by comparing the aggregated damage values of Exhibits 4-2 and 4-6 (the without and with conditions respectively).

TABLE 1
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1	1	GRID CELL ROW
	2-92	Row 1 Rows 2-92
2	1	GRID CELL COLUMN
	2-129	Column 1 Columns 2-129
3	1	WATERSHED Trail Creek
5	1	DAMAGE REACH
	2-5	Damage reach 1 Damage reaches 2-5
10	1	EXISTING LAND USE
	2	Natural vegetation
	3	Developed open space
	4	Low density residential
	5	Medium density residential
	6	High density residential
	7	Agricultural
	8	Industrial
	9	Commercial
	10	Pasture Water bodies
11	1	1990 ALTERNATIVE LAND USE PATTERN
	2	Natural vegetation
	3	Developed open space
	4	Low density residential
	5	Medium density residential
	6	High density residential
	7	Agricultural
	8	Industrial
	9	Commercial
	10	Pasture Water bodies

TABLE 1 (continued)
DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
13		REFERENCE FLOOD ELEVATION Flood elevations to the nearest .1 foot are stored for each grid cell in the flood plain
14		TOPOGRAPHIC ELEVATION Land elevations to the nearest .1 foot are stored for each grid cell in the study area

GENERAL PURPOSE DATA FORM
(8 COLUMN FIELD)

PROJECT	DATE	PREPARED BY	CHECKED BY	PAGE
DAMCAL - EXHIBIT 4-6	January 1979	D. GUNDLACH		1
SAMPLE PARABLEM				
INITIATING FLOOD PLAIN REGULATION, FLOOD PROTECTING, JANUARY 1979				
AND EVACUATION				
11	2	1	1	0
12	1	18	129	0
13	3	11	10	13
14	3	5		31
15	3	5		
16	3	5		
17	3	5		
18	1	1		
TULARE, 10 FEB. 2, 1979, 10 FEB. 2				
5720 YR 10 YR 20 YR 30 YR 100 YR				
19	1	1	1	1.00
20	1	1	1	1.00
21	1	1	1	1.00
22	1	1	1	1.00
23	1	1	1	1.00
24	1	1	1	1.00
25	1	1	1	1.00
26	1	1	1	1.00
27	1	1	1	1.00
28	1	1	1	1.00
29	1	1	1	1.00
30	1	1	1	1.00
31	1	1	1	1.00
32	1	1	1	1.00
33	1	1	1	1.00
34	1	1	1	1.00
35	1	1	1	1.00
36	1	1	1	1.00
37	1	1	1	1.00
38	1	1	1	1.00
39	1	1	1	1.00
40	1	1	1	1.00
41	1	1	1	1.00
42	1	1	1	1.00
43	1	1	1	1.00
44	1	1	1	1.00
45	1	1	1	1.00
46	1	1	1	1.00
47	1	1	1	1.00
48	1	1	1	1.00
49	1	1	1	1.00
50	1	1	1	1.00
51	1	1	1	1.00
52	1	1	1	1.00
53	1	1	1	1.00
54	1	1	1	1.00
55	1	1	1	1.00
56	1	1	1	1.00
57	1	1	1	1.00
58	1	1	1	1.00
59	1	1	1	1.00
60	1	1	1	1.00
61	1	1	1	1.00
62	1	1	1	1.00
63	1	1	1	1.00
64	1	1	1	1.00
65	1	1	1	1.00
66	1	1	1	1.00
67	1	1	1	1.00
68	1	1	1	1.00
69	1	1	1	1.00
70	1	1	1	1.00
71	1	1	1	1.00
72	1	1	1	1.00
73	1	1	1	1.00
74	1	1	1	1.00
75	1	1	1	1.00
76	1	1	1	1.00
77	1	1	1	1.00
78	1	1	1	1.00
79	1	1	1	1.00
80	1	1	1	1.00
81	1	1	1	1.00
82	1	1	1	1.00
83	1	1	1	1.00
84	1	1	1	1.00
85	1	1	1	1.00
86	1	1	1	1.00
87	1	1	1	1.00
88	1	1	1	1.00
89	1	1	1	1.00
90	1	1	1	1.00
91	1	1	1	1.00
92	1	1	1	1.00
93	1	1	1	1.00
94	1	1	1	1.00
95	1	1	1	1.00
96	1	1	1	1.00
97	1	1	1	1.00
98	1	1	1	1.00
99	1	1	1	1.00
100	1	1	1	1.00

[illegible]

[illegible]

PROGRAM	REQUESTED BY	EXHIBIT	DATE	PAGE
DYNAMICAL	2. Burdick	4-6	January 1979	1
RECEIVED BY				
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100
101	102	103	104	105
106	107	108	109	110
111	112	113	114	115
116	117	118	119	120
121	122	123	124	125
126	127	128	129	130
131	132	133	134	135
136	137	138	139	140
141	142	143	144	145
146	147	148	149	150
151	152	153	154	155
156	157	158	159	160
161	162	163	164	165
166	167	168	169	170
171	172	173	174	175
176	177	178	179	180
181	182	183	184	185
186	187	188	189	190
191	192	193	194	195
196	197	198	199	200
201	202	203	204	205
206	207	208	209	210
211	212	213	214	215
216	217	218	219	220
221	222	223	224	225
226	227	228	229	230
231	232	233	234	235
236	237	238	239	240
241	242	243	244	245
246	247	248	249	250
251	252	253	254	255
256	257	258	259	260
261	262	263	264	265
266	267	268	269	270
271	272	273	274	275
276	277	278	279	280
281	282	283	284	285
286	287	288	289	290
291	292	293	294	295
296	297	298	299	300
301	302	303	304	305
306	307	308	309	310
311	312	313	314	315
316	317	318	319	320
321	322	323	324	325
326	327	328	329	330
331	332	333	334	335
336	337	338	339	340
341	342	343	344	345
346	347	348	349	350
351	352	353	354	355
356	357	358	359	360
361	362	363	364	365
366	367	368	369	370
371	372	373	374	375
376	377	378	379	380
381	382	383	384	385
386	387	388	389	390

```

J1 CARD
*****
CCC 12345678901234567890123456789012345678901234567890
J1  2  4  2  0  1  0  5  0
IPDL = 2, SPECIFIED NEW DEVELOPMENT WILL HAVE THEIR GROUND FLOOR
      PLACED ABOVE A POLICY LEVEL
IPROP = 4, SPECIFIED NEW DEVELOPMENT WILL BE FLOOD PROOFED TO A SPECIFIED LEVEL
IEVAC = 2, EVACUATE ALL NEW DEVELOPMENT WHICH HAS ITS GROUND LEVEL
      IN THE RESTRICTED FLOOD PLAIN
IEVCLU = 2, EVACUATED CELLS WILL BE AGGREGATED INTO THIS LAND USE CATEGORY
IPRNT = 0, NORMAL PRINTOUT
ITRACE = 1, TRACE OUTPUT REQUESTED
IAUTO = 0, NO FILE CREATED FOR ATDDTA PROGRAM
ITYPE = 3, NUMBER OF SINGLE EVENT DAMAGES TO BE CALCULATED
IAG = 0, NO AGGREGATION OF SINGLE EVENT DAMAGES

```

J2 CARD

CC 12345678901234567890123456789012345678901234567890
J2 1 1 10 92 129 0

```
DATA BANK INFORMATION
=====
INFILE = 1, THE DATA BANK IS ON THIS COMPUTER UNIT
INFORM = 1, THE DATA BANK IS FORMATTED
INDV = 10, THE NUMBER OF DATA VARIABLES
IRON = 92, THE NUMBER OF RONS IN THE DATA BANK
ICOL = 129, THE NUMBER OF COLUMNS IN THE DATA BANK
IMAGE = 0, NO PRINTED IMAGE OF INPUT DECK
```

J3 CARD

CC 123456789012345678901234567890123456789012345678901234567890
J3 3 5 2 11 10 14 13 31

DATA VARIABLE INFORMATION

IDMRC = 5, THE DATA VARIABLE THAT IS THE DAMAGE REACH CODE
NOOR = 2, THE NUMBER OF DAMAGE REACHES IN THIS ANALYSIS
ILAND = 11, THE DATA VARIABLE THAT IS THE LAND USE ANALYZED
IBASE = 10, THE DATA VARIABLE CONSIDERED THE BASE CONDITION
NOLUC = 10, THE NUMBER OF LAND USE CATEGORIES
ITOPG = 14, THE DATA VARIABLE THAT IS TOPOGRAPHY
IRFPD = 13, THE DATA VARIABLE THAT IS THE REFERENCE FLOOD ELEVATION
Y = 31, THE NUMBER OF ELEVATION-DAMAGE POINTS TO BE CALCULATED

THE FOLLOWING LAND USE CATEGORIES
ARE SUBJECT TO POLICY CONTROLS

J4 CARD (8)

CC 123456789012345678901234567890123456789012345678901234567890
J4 3 4 5

THE FOLLOWING LAND USE CATEGORIES WITH NEW
DEVELOPMENT ARE SUBJECT TO FLOOD PROOFING

J5 CARD (8)

CC 123456789012345678901234567890123456789012345678901234567890
J5 3 4 5

THE FOLLOWING LAND USE CATEGORIES WITH
NEW DEVELOPMENT ARE SUBJECT TO EVACUATION

J7 CARD (8)

CC 123456789012345678901234567890123456789012345678901234567890
J7 3 4 5

J8 CARD

CC 123456789012345678901234567890123456789012345678901234567890
J8 3 4 5

TRACE INFORMATION

WNRB = 1, TRACE OUTPUT PROVIDED IN THIS DAMAGE REACH
WMLU = 4, TRACE OUTPUT PROVIDED FOR THIS LAND USE CATEGORY

FORMAT CARD

CC 123456789012345678901234567890123456789012345678901234567890
PY(1234,0.25,2.25,0.25,0)

Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)

SAMPLE PROBLEM
UTILIZING FLOOD PLAIN REGULATION, FLOOD PROOFING,
AND EVACUATION

EXHIBIT 4-6
JANUARY 1979

LAND USE CATEGORY NO. 4

MEDIUM DENSITY HOUSING

DEPTH OF WATER	PERCENT DAMAGE TO STRUCTURES	PERCENT DAMAGE TO CONTENTS	PERCENT DAMAGE TO OTHER	AMOUNT OF DAMAGE PER SQ. FT. CELL	AMOUNT OF DAMAGE PER THOUSAND DOLLARS
-2.01	0.	0.	0.	0.	0.
-2.00	1.00	0.	5.00	.20	.20
-1.00	2.00	0.	5.00	.30	.30
0.	9.00	2.00	5.00	2.69	2.69
1.00	11.00	30.00	5.00	5.60	5.60
2.00	18.00	48.00	5.00	9.07	9.07
3.00	24.00	58.00	5.00	11.59	11.59
4.00	26.00	64.00	5.00	12.66	12.66
5.00	29.00	68.00	5.00	13.83	13.83
6.00	31.00	70.00	4.00	14.96	14.96
7.00	32.00	71.00	4.00	14.92	14.92
8.00	35.00	71.00	4.00	15.76	15.76
9.00	36.00	73.00	4.00	16.21	16.21
10.00	36.00	74.00	4.00	16.30	16.30
11.00	40.00	74.00	3.00	17.42	17.42
12.00	40.00	74.00	3.00	17.42	17.42
13.00	41.00	74.00	3.00	17.70	17.70
14.00	42.00	74.00	3.00	17.98	17.98
15.00	43.00	74.00	3.00	18.26	18.26
16.00	44.00	74.00	2.00	18.54	18.54
17.00	45.00	74.00	2.00	18.82	18.82
18.00	45.00	74.00	2.00	18.82	18.82
19.00	45.00	74.00	2.00	18.82	18.82
20.00	45.00	74.00	2.00	18.82	18.82

DENSITY IN THE LAND USE UNIT PER GRID CELL = 4.00

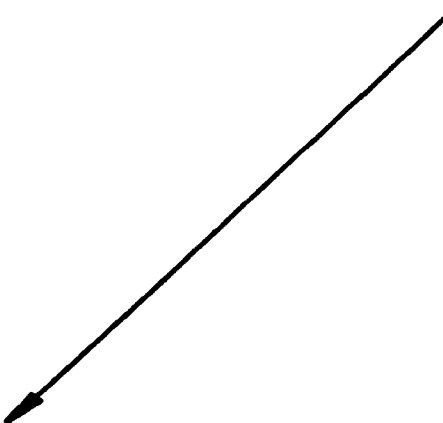
BASE VALUE OF THE STRUCTURE = 10000.00

BASE VALUE OF THE CONTENTS (30.00 PERCENT OF THE STRUCTURE VALUE) = 3000.00

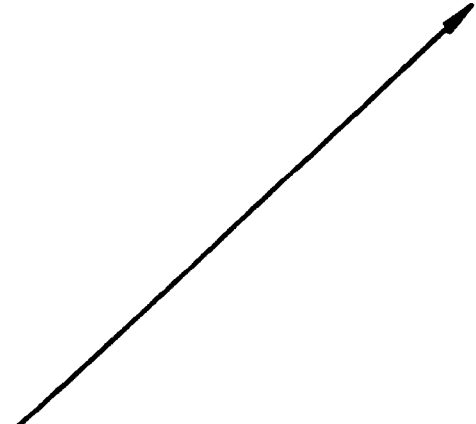
BASE VALUE OF OTHER = 0.

VACANCY FACTOR (PERCENT DEVELOPED) = 70.0

ONLY NEW DEVELOPMENT WITH THIS LAND USE WILL BE RAISED TO THE GROUND FLOOD IN A SPECIFIC LEVEL
ONLY NEW DEVELOPMENT IN THIS LAND USE WILL BE FLOOD PROOFED TO A SPECIFIED PROTECTION LEVEL



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



LAND USE CATEGORY NO. 7

INDUSTRIAL

DEPTH OF WATER	PERCENT OF DAMAGE TO STRUCTURE	PERCENT OF DAMAGE TO CONTENTS	PERCENT OF DAMAGE TO OTHER	AMOUNT OF DAMAGE PER GRID CELL IN THOUSAND DOLLARS
-2.01	0.	0.	0.	0.
-2.00	1.00	0.	0.	1.10
-1.00	1.00	0.	0.	1.10
0.	7.00	5.00	5.00	19.61
1.00	12.00	28.00	15.00	71.22
2.00	18.00	37.00	20.00	96.73
3.00	24.00	43.00	22.00	115.43
4.00	27.00	49.00	30.00	133.59
5.00	29.00	53.00	45.00	154.07
6.00	31.00	59.00	50.00	166.01
7.00	32.00	63.00	55.00	176.77
8.00	35.00	67.00	80.00	199.64
9.00	36.00	71.00	85.00	213.01
10.00	40.00	75.00	90.00	224.95
11.00	44.00	81.00	95.00	242.79
12.00	44.00	85.00	95.00	249.67
13.00	45.00	85.00	95.00	251.05
14.00	45.00	85.00	95.00	251.05
15.00	46.00	85.00	95.00	252.23
16.00	47.00	85.00	95.00	253.41

DENSITY OF THE LAND USE UNITS PER GRID CELL = .20

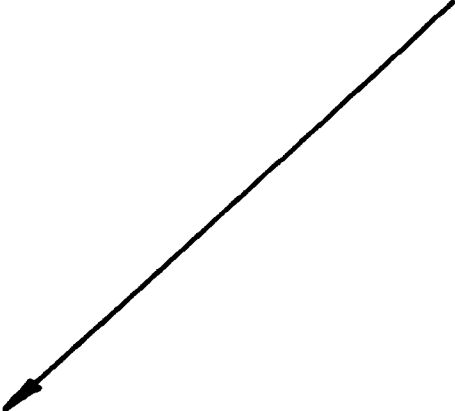
BASE VALUE OF THE STRUCTURE \$500000.00

BASE VALUE OF THE CONTENTS \$85000.00

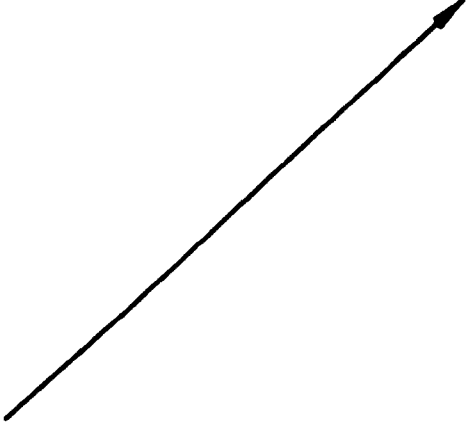
BASE VALUE OF OTHER \$25000.00

VACANCY FACTOR (PERCENT DEVELOPED) = 100.0

ALL GRID CELLS WITH NEW DEVELOPMENT AND THIS LAND USE WHICH HAVE THEIR BOUND FLOOD IN THE RESTRICTED FLOOD PLAIN WILL BE EVACUATED AND THE DAMAGES WILL BE ALLOCATED INTO LAND USE



Several pages of printout
deleted relating to the stage-
damage functions for particular
land use categories (stage-damage
functions are identical to those
shown in Exhibit 4-2 for the ten
land use categories)



SAMPLE PROBLEM
UTILIZING FLOOD PLAIN REGULATION, FLOOD PROOFING, EXHIBIT 4-6
AND EVACUATION
JANUARY 1979

DAMAGE REACH INDEX LOCATION SUMMARY

ID. NO.	REFERENCE FLOOD ELEVATION	POLICY FLOOD ELEVATION	FLOOD PROOFING ELEVATION	EVACUATION ELEVATION	STARTING DAMAGE ELEVATION	DAMAGE ELEVATION INCREMENT	AGGREGATED DAMAGE KLM. IU.	FLOODING LAND USE DENSITY
1.	638.0	627.1	627.1	624.0	610.0	1.00	0	0
3.	714.0	711.9	711.9	710.8	695.0	1.00	0	0

SINGLE EVENTS FOR DAMAGE REACHES

DAMAGE REACH NO.	2 YEAR EVENT	10 YEAR EVENT	20 YEAR EVENT	50 YEAR EVENT	100 YEAR EVENT
1.	616.7	623.5	624.0	625.6	627.1
3.	708.6	710.2	710.8	711.5	711.9

DAMAGE REACH 1 IS BEING TRACED FOR LAND USE 4

* INDICATED ELEVATION IS AT GRID CELL

ROW	COL	ARRAY BASE ALT. INDEX L.U. L.U.	REF. FLOOD ELEV.	POLICY ELEV.	*TOPD BEFORE POLICY	*TOPD AFTER POLICY	FLOOD PROOF ELEV.	*EVAC. ELEV.	DAMAGE FUNCT. STAGE	DAMAGE ELEV.	DAMAGE	ACCUM. DAMAGE
80	7	16	2	4	620.00	613.10	600.00	613.10	627.10	-2.10	625.00	0.
80	7	17	2	4	620.00	613.10	600.00	613.10	627.10	-1.10	626.00	0.
80	7	18	2	4	620.00	613.10	600.00	613.10	627.10	-1.10	627.00	0.
80	7	19	2	4	620.00	613.10	600.00	613.10	627.10	0.	628.00	5.31
80	7	20	2	4	620.00	613.10	600.00	613.10	627.10	1.90	629.00	6.72
80	7	21	2	4	620.00	613.10	600.00	613.10	627.10	4.90	630.00	11.34
80	7	22	2	4	620.00	613.10	600.00	613.10	627.10	3.90	631.00	14.55
80	7	23	2	4	620.00	613.10	600.00	613.10	627.10	4.90	632.00	13.71
80	7	24	2	4	620.00	613.10	600.00	613.10	627.10	5.90	633.00	14.49
80	7	25	2	4	620.00	613.10	600.00	613.10	627.10	6.90	634.00	14.89
80	7	26	2	4	620.00	613.10	600.00	613.10	627.10	7.90	635.00	15.68
80	7	27	2	4	620.00	613.10	600.00	613.10	627.10	8.90	636.00	16.17
80	7	28	2	4	620.00	613.10	600.00	613.10	627.10	9.90	637.00	16.29
80	7	29	2	4	620.00	613.10	600.00	613.10	627.10	10.90	638.00	17.30
80	7	30	2	4	620.00	613.10	600.00	613.10	627.10	11.90	639.00	17.42
80	7	31	2	4	620.00	613.10	600.00	613.10	627.10	12.90	640.00	17.67
80	8	22	2	4	620.00	613.10	620.00	620.00	627.10	-2.00	631.00	0.
80	8	23	2	4	620.00	613.10	620.00	620.00	627.10	-2.00	632.00	12.55
80	8	24	2	4	620.00	613.10	620.00	620.00	627.10	-1.00	633.00	13.59
80	8	25	2	4	620.00	613.10	620.00	620.00	627.10	0.	634.00	15.09
80	8	26	2	4	620.00	613.10	620.00	620.00	627.10	1.00	635.00	17.38
80	8	27	2	4	620.00	613.10	620.00	620.00	627.10	2.00	636.00	21.28
80	8	28	2	4	620.00	613.10	620.00	620.00	627.10	3.00	637.00	25.28
80	8	29	2	4	620.00	613.10	620.00	620.00	627.10	4.00	638.00	27.88
80	8	30	2	4	620.00	613.10	620.00	620.00	627.10	5.00	639.00	29.94
80	8	31	2	4	620.00	613.10	620.00	620.00	627.10	6.00	640.00	31.25
80	8	31	2	4	620.00	613.10	620.00	620.00	627.10	6.00	640.00	32.63

DAMAGE REACH 1 HAS 1. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS
DAMAGE REACH 3 HAS 1. CELLS THAT WERE RAISED TO COMPLY WITH POLICY CONTROLS

DAMAGE REACH 1 HAS 2. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVELS
DAMAGE REACH 3 HAS 4. CELLS THAT WERE FLOOD PROOFED TO SPECIFIED LEVELS

DAMAGE REACH 1 HAS 8. CELLS THAT WERE EVACUATED

DAMAGE REACH 3 HAS 12. CELLS WITH DAMAGES STARTING BELOW THE STARTING AGGREGATION ELEVATION

DAMAGE REACH 1 HAS 180. CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION
DAMAGE REACH 3 HAS 137. CELLS WITH DAMAGES STARTING ABOVE THE HIGHEST AGGREGATION ELEVATION

SAMPLE PROBLEM
UTILIZING FLOOD PLAIN REGULATION, FLOOD PROOFING,
AND EVACUATION
DAMAGE REACH NO. 1

EXHIBIT 4-6

JANUARY 1979

DAMAGE REACH 1-OCONEE TO COMPLUENCE

LAND USE CATEGORIES												
WATER SURFACE ELEVATION	1	2	3	4	5	6	7	8	9	10	TOTAL	
610.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
611.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
612.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
613.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
614.0	.15	.70	0.	0.	0.	0.	0.	0.	0.	0.	.85	
615.0	.15	.70	0.	0.	0.	0.	0.	0.	.07	0.	.92	
616.0	.15	.70	0.	0.	0.	0.	0.	0.	.10	0.	.95	
617.0	.20	.70	0.	0.	0.	0.	0.	0.	.12	0.	1.02	
618.0	.25	.80	0.	0.	0.	0.	0.	0.	.15	0.	1.20	
619.0	.25	.80	0.	0.	0.	0.	0.	0.	.18	0.	1.23	
620.0	.35	.80	0.	0.	0.	0.	0.	0.	.25	0.	1.40	
621.0	.40	.80	0.	0.	0.	0.	0.	0.	.27	0.	1.47	
622.0	.45	.80	0.	0.	0.	0.	0.	0.	.29	0.	1.54	
623.0	.45	.80	0.	0.	0.	0.	0.	0.	.31	0.	1.56	
624.0	.55	1.10	0.	0.	0.	0.	0.	0.	.33	0.	1.96	
625.0	.55	1.10	0.	0.	0.	0.	0.	0.	.39	0.	2.04	
626.0	.55	1.10	0.	0.	0.	0.	0.	0.	.41	0.	2.06	
627.0	.70	1.10	0.	0.	0.	0.	0.	0.	.43	0.	2.23	
627.1	.70	1.20	0.	0.	0.	0.	0.	0.	.43	0.	2.33	
628.0	.80	1.20	0.	5.1	0.	0.	0.	0.	.46	0.	7.77	
629.0	.80	1.20	0.	8.72	0.	0.	0.	6.40	.49	0.	17.71	
630.0	1.10	1.20	0.	11.34	0.	0.	0.	19.00	.52	0.	33.62	
631.0	1.15	1.20	0.	12.55	0.	0.	0.	32.51	.55	0.	47.96	

DAMAGE CATEGORY	LAND USE CODE	LAND USE	1	2	3	4	5	6	7	8	9	10
632.0	1.15	1.20	0.	15.99	0.	0.	0.	0.	0.	0.	0.	62.44
633.0	1.25	1.20	0.	15.05	0.	0.	0.	0.	0.	0.	0.	76.76
634.0	1.80	1.80	0.	17.58	0.	0.	0.	0.	0.	0.	0.	43.56
635.0	1.80	1.80	0.	21.28	0.	0.	0.	0.	0.	0.	0.	242.09
636.0	1.80	1.80	0.	25.24	0.	0.	0.	0.	0.	0.	0.	365.15
637.0	1.80	1.80	0.	27.88	0.	0.	0.	0.	0.	0.	0.	458.76
638.0	1.80	1.80	0.	29.96	0.	0.	0.	0.	0.	0.	0.	507.01
639.0	1.85	1.80	0.	31.25	0.	0.	0.	0.	0.	0.	0.	545.24
640.0	1.90	1.80	0.	32.23	0.	0.	0.	0.	0.	0.	0.	578.47
616.7	.20	.70	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.02
623.5	.45	.90	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.47
624.0	.55	1.10	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.98
625.6	.55	1.10	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.05
627.1	.70	1.20	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.33

DAMAGE CATEGORY	LAND USE CODE	LAND USE
1	1	NATURAL VEGETATION
2	2	DEVELOPED OPEN SPACE
3	3	LOW DENSITY HOUSING
4	4	MEDIUM DENSITY HOUSING
5	5	HIGH DENSITY HOUSING
6	6	AGRICULTURE
7	7	INDUSTRIAL
8	8	COMMERCIAL
9	9	PASTURE
10	10	WATER BODIES

SAMPLE PROBLEM
UTILIZING FLOOD PLAIN REGULATION, FLOOD PROOFING,
AND EVACUATION
DAMAGE REACH NO. 3

EXHIBIT 4-6
JANUARY 1979

DAMAGE REACH 3-LAST SECTION OF WEST FORK

LAND USE CATEGORIES										
WATER SURFACE ELEVATION	1	2	3	4	5	6	7	8	9	TOTAL
695.0	.60	0.	0.	0.	0.	0.	0.	0.	0.	.60
696.0	.70	0.	0.	0.	0.	0.	0.	0.	0.	.70
697.0	.75	0.	0.	0.	0.	0.	0.	0.	0.	.75
698.0	.75	0.	0.	0.	0.	0.	0.	0.	0.	.75
699.0	.80	0.	0.	0.	0.	0.	0.	0.	0.	.80
700.0	.85	0.	0.	0.	0.	0.	0.	0.	0.	.85
701.0	.90	0.	0.	0.	0.	0.	0.	0.	0.	.90
702.0	.95	0.	0.	0.	0.	0.	0.	0.	0.	.95
703.0	1.00	0.	0.	0.	0.	0.	0.	0.	0.	1.00
704.0	1.05	0.	0.	0.	0.	0.	0.	0.	0.	1.05
705.0	1.05	0.	0.	0.	0.	0.	0.	0.	0.	1.05
706.0	1.15	0.	0.	0.	0.	0.	0.	0.	0.	1.15
707.0	1.25	0.	0.	0.	0.	0.	0.	0.	0.	1.25
708.0	1.35	0.	0.	0.	0.	0.	0.	0.	0.	1.35
709.0	1.45	0.	0.	0.	0.	0.	0.	0.	0.	1.45
710.0	1.60	0.	0.	0.	0.	0.	0.	0.	0.	1.60
710.8	1.95	0.	0.	0.	0.	0.	0.	0.	0.	1.95
711.0	1.95	0.	0.	0.	0.	.01	0.	0.	0.	1.96
711.9	2.10	0.	0.	0.	0.	.04	0.	0.	0.	2.14
712.0	2.10	0.	0.	0.	42.42	.04	0.	0.	0.	44.56
713.0	2.30	0.	0.	0.	120.96	.03	0.	0.	0.	123.39
714.0	2.80	0.	0.	0.	165.66	.06	0.	0.	0.	168.51
715.0	3.20	0.	0.	0.	200.76	.15	0.	0.	.15	204.26

EXHIBIT 4-7

INPUT DESCRIPTION

**DAMAGE REACH STAGE-DAMAGE CALCULATION
PROGRAM NAME - DAMCAL**

EXHIBIT 4-7

INPUT DESCRIPTION

DAMAGE REACH STAGE-DAMAGE CALCULATION

PROGRAM NAME - DAMCAL

This exhibit provides a detailed description of the DAMCAL data input requirements, card by card and variable by variable.

The field number designates the location of the variables on each input card. Card columns 1-2 are reserved for the card identifiers and are referred to as Field 0. Field 1 ranges from card columns 3-8; Fields 2-10 contain eight card columns each. An abbreviated field location nomenclature is used to identify the field location. The card name is followed by a decimal point and the field number. For example, LU.8 refers to the eighth field on the LU card. All variables beginning with I, J, K, L, M, and N should have integer values (no decimal point) and be right-justified (the values shifted to the right within each field). A "+" sign under the value heading indicates the placement of a positive numerical value in that field. A "-" sign indicates a negative numerical value in that field. "AN" means that a combination of alphanumeric characters is allowed. The variable value of zero should be keypunched on the card, as a blank field on some computer systems will be read as a negative zero which may cause logic problems in the software. When a number does not have a sign, a positive value will be assumed.

TITLE CARDS

T1, T2, T3 Cards: (Required Cards)

These cards provide up to three lines of information at the top of each page of output.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	T1, T2 or T3	Card identification (3 cards)

T1, T2, T3 Cards (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
1-10	TITLE	AN	Title information (center of title falls in card column 41).

JOB CARDS

J1 Card: First Job Card (Required Card)

This card describes the type of analysis to be performed, the printout option and the file management option.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J1	Card identification
1	IPOL	0	Land use under analysis is the base condition.
		1	Land use under analysis is a modified or projected land use pattern. Zero stage of all specified land use categories to be raised above the specified flood level (J4 and DR cards).
		2	Land use under analysis is a modified or projected land use pattern. All specified <u>new</u> development to be located such that the zero stage is above a specified flood level (J4 and DR cards).
		3	Land use under analysis is a modified or projected land use pattern. All specified land uses to be located such that the <u>zero damage</u> elevation (the highest elevation for a grid cell exhibiting no damage) is above a specified flood level (J4 and DR cards).
		4	Land use under analysis is a modified or projected land use pattern. All specified <u>new</u> development to be located such that the <u>zero damage</u> elevation (the highest elevation for a grid cell exhibiting no damage) is above a specified flood level (J4 and DR cards).

J1 Card: First Job Card (Continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
2	IPROF	0	No flood proofing is required in this computer run.
		1	All indicated land use categories are flood proofed to a specified depth with reference to the zero stage (J5 and J6 cards).
		2	Only <u>new</u> development of indicated land use categories are floodproofed to a specified depth with reference to the zero stage (J5 and J6 cards).
		3	All indicated land use categories are floodproofed to a specified protection level flood event (J5 and DR cards).
		4	Only <u>new</u> development of indicated land use categories are floodproofed to a specified protection level flood event (J5 and DR cards).
3	IEVAC	0	No permanent evacuation.
		1	Permanent evacuation of specified land use categories which have a zero stage elevation in the restricted flood plain (J7 and DR cards).
		2	Only <u>new</u> development of indicated land use categories which have a zero stage elevation in the restricted flood plain are permanently evacuated (J7 and DR cards).
		3	Permanent evacuation of specified land use categories which have a <u>zero damage</u> elevation (the highest elevation for a grid cell exhibiting no damage) in the restricted flood plain (J7 and DR cards).
		4	Only <u>new</u> development of indicated land use categories which have a <u>zero damage</u> elevation (the highest elevation for a grid cell exhibiting no damage) in the restricted flood plain are permanently evacuated (J7 and DR cards).

J1 Card: First Job Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
4	IEVCLU	+	The land use category into which permanently evacuated grid cells are transformed. A value should be specified when IEVAC (J1.3) is greater than zero. If blank or zero, a zero damage potential is assumed for the evacuated grid cell.
5	IPRNT	0	Normal printout.
		1	Suppress land use economic printout.
6	ITRACE	0	Suppress trace printout.
		1	Trace output is requested (J8 card).
7	IAUTO	0	No ATODTA input file is created
		1	Create input damage file for ATODTA (Tape 20 should be saved at end of execution).
8	ITYPE	0	Aggregated elevation-damage curves only.
		+	Number of single flood event damages calculated (maximum of 10).
9	IAG	0	No single flood event aggregation
		1	Aggregate single flood event (LU.10 & DR.8).

J2 Card: Second Job Card (Required Card)

This card describes the location of the data bank, the number of data variables, the dimensions of the data base, and whether or not the grid cell data bank is formatted.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J2	Card identification
1	NFILE	1	The DATA BANK is located on input unit 1.
		5	The DATA BANK is on computer cards.
2	NFORM	0	The DATA BANK is unformatted.
		1	The DATA BANK is formatted.

J2 Card: Second Job Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
3	NDV	+	The number of data variables in the DATA BANK.
4	IROW	+	The number of rows in the DATA BANK.
5	ICOL	+	The number of columns in the DATA BANK.
6	IMAGE	0	No input card images are provided.
		1	Input card images are provided at the beginning of the output.

J3 Card: Third Job Card (Required Card)

C

This card defines the sequence numbers of the data variables used in the analysis and the number of categories for particular data variables.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J3	Card identification
1	IDAMRC	+	The sequence number of the damage reach variable.
2	NODR	+	The number of damage reaches in the analysis.
3	ILAND	+	The sequence number of the land use variable to be analyzed. (This will be the base condition if IBASE (J3.4) = 0 or the alternative future condition if IBASE is positive).
4	IBASE	0	The base condition is analyzed.
		+	The sequence number of the land use variable that is the base condition for locating new development.
5	NOLUC	+	The number of land use categories in ILAND (J3.3).
6	ITOP0	+	The sequence number of the topography elevation variable.
7	IRFED	+	The sequence number of the reference flood elevation variable.
8	IELV	+	The number of elevations to be calculated for the elevation-damage relationships.

J4 Card: Fourth Job Card (Optional Card)

The J4 card(s) is used when IPOL (J1.1) is greater than zero. Up to three J4 cards can be used. If the last J4 value input is JPOL (10) or JPOL (20), then a blank J4 card must follow. The order in which land use categories are input is not important.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J4	Card identification
1	JPOL(1)	+	Land use category to be raised above the specified flood elevation.
2	JPOL(2)	+	Etc., up to a maximum of 30 land use categories.

J5 Card: Fifth Job Card (Optional Card)

The J5 card(s) is used when IPRUF (J1.2) is greater than zero. Up to three J5 cards can be used. If the last J5 value input is JPRF(10) or JPRF (20) then a blank J5 card must follow. The order in which land use categories are input is not important.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J5	Card identification
1	JPRF(1)	+	Land use category to be floodproofed.
2	JPRF(2)	+	Etc., up to a maximum of 30 land use categories.

J6 Card: Sixth Job Card (Optional Card)

The J6 card(s) is used when IPRUF (J1.2) = 1 or 2. The depth of floodproofing is in reference to the zero stage and the order of input must correspond to the appropriate J5 card value. Up to three J5 cards can be used. If the last J6 value input is DROF(10) or DROF(20) then a blank J6 card must follow.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J6	Card identification
1	DROF(1)	+	Depth of floodproofing for the land use category indicated in J5.1.
2	DROF(2)	+	Etc., up to a maximum of 30 land use categories.

J7 Card: Seventh Job Card (Optional Card)

An optional card(s) used to specify land use categories that will be permanently evacuated. Up to three J7 cards can be used. If the last J7 value input is JEVAC(10) or JEVAC(20) then a blank J7 card must follow. The order in which land use categories are input is not important.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J7	Card identification
1	JEVAC(1)	+	Land use category to be permanently evacuated.
2	JEVAC(2)	+	Etc., up to a maximum of 30 land use categories.

J8 Card: Eighth Job Card (Optional Card)

This is an optional card used only when ITRACE (J1.6) = 1.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	J8	Card identification
1	NNDR	+	Damage reach to be traced. Should correspond to a value JDR(I), on the (or a) DR card.
2	NNLU	+	Land use category to be traced within the damage reach indicated above.

FT Card: Format Card (Optional Card)

This card is used only when the data bank is formatted, NFORM (J2.2) = 1. A set of parenthesis is needed to inclose the format statement.

<u>Column</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
1-2	CODE	FT	Card identification
3-80	FMT(I)	(AN)	The format description must have a left parenthesis in card column 3. The description of the format must be in a fixed point format. The end of the format must be followed with a right parenthesis.

ST Card: Single Flood Event Title Card (Optional Card)

This card required only when single flood event analysis is performed, ITYPE (J1.8) is positive. ITYPE number of values are input, up to a maximum of ten (10).

ST Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	ST	Card identification
1	SEVTIT(1)	AN	Title of first flood event.
2	SEVTIT(2)	AN	Etc., ITYPE(I) items.

COMPOSITE LAND USE CARDS

One set of Composite Land Use Cards (LU, LT, DF, DS, DC, DO, DD) is needed for each land use category included within ILAND (J3.3).

LU Card: Land Use Damage Card (Required Card)

NOLUC (J3.5) number of LU cards are required.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	LU	Card identification
1	LUC	+	Land use category number.
2	INPET	0	DD cards are used.
		1	DS, DC and DO cards are used.
*** If INPET = 0, fields 3 through 7 on this card should reflect the values used to calculate the composite stage damage values input on the DD cards.			
3	DENSITY	+	Number of damageable units per grid cell.
4	BASEVAL	+	Average dollar value of the structure.
5	BASEVLU	+	Average dollar value of the contents.
		0	No content value.
		-	Percent of structure value that is used to calculate the value of the contents (30% is recorded as -.30).
6	BASEIND	+	Dollar value of other damages.
		0	No value.
		-	The value input on the DO card is used to calculate other damages.

LU Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
7	VACNCY	+	The percent of developed land within the grid cell (80% is recorded as .80). The default value = 100%.
8	NDAM	+	The number of depth values to be read on the DF cards up to a maximum of 30 values.
9	IPROT	0	Normal printout
		1	Suppress composite damage printout for this land use type.
10	IAGGLU(I)	+	Used only when IAG (J1.9) = 1. The value will be the sequence number of the new land use category created by the aggregation of the land use category in LUC. (Several LUC, land use categories, can be combined into a <u>single</u> new land use category). The specified new values must be in sequence starting with 1 up to a maximum specified value of 10.

LT Card: Land Use Title Card (Required Card)

This card is used for the zero stage adjustment and land use title.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	LT	Card identification
1	LUCT	+	Land use category on preceding LU card.
2	DEPADJ	0	The zero stage of the composite damage function and the grid cell elevation in the DATA BANK are both based on the ground elevation.
		+ or -	Depth of flooding adjustment (in feet) made to the stages of the composite damage function when the zero stage is <u>not</u> based on ground elevation. (Used only when the zero stage of the composite damage curves are based on a first floor datum that is different than the corresponding ground datum). A positive value would indicate a first floor level above the corresponding ground level.

LT Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
3-8	TITLU	AN	Title of land use category.

DF Card: Depth of Flooding Card (Required Card)

There is a maximum of three DF cards per land use. There must be NDAM (LU.8) number of values on this card or cards.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DF	Card identification
1-10	DEPTH(I)	+ or -	The depth of flooding values for the stage-damage curve. If more than 10 stages, the eleventh value is placed in field 1 of the next DF card.

DS Card: Damage to Structure Card (Optional Card)

The DS card is used if INP T (LU.2) = 1. The card values must be input in the same order as the corresponding depth of flooding values on the DF card(s), NDAM (LU.8) values. (The DD card must be input if this card is not used).

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DS	Card identification
1-10	DS(I)	0 or +	The percent of damage to the structure which corresponds to the depth of flooding on the DF card (30% is input as 30).

DC Card: Damage to Contents Card (Optional Card)

An optional card(s) in which the values must be input in the same order as the corresponding depth of flooding values on the DF cards, NDAM (LU.8) values. The DC card is needed in conjunction with the DS card.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DC	Card identification
1-10	DC(I)	0 or +	The percent of damage to the contents which corresponds to the depth of flooding on the DF card (30% is input as 30).

DO Card: Other Damages Card (Optional Card)

An optional card(s) in which the values must be input in the same order as the corresponding depth of flooding vlaues on the DF cards, NDAM (LU.8) values. The DO card is needed in conjunction with the DC and DS cards.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DO	Card identification
1-10	DO(I)	0 or +	The percent of damage to structure and contents (corresponding to DF values) that reflects other damages (30% is recorded as 30). If LU.6 is positive, DO(I) is the percent of LU.6 that then represents other damages.

DD Card: Total Damage Card (Optional Card)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DD	Card identification
1-10	DAMAGE(I)	+	Total dollar damages for the corresponding depth of flooding value on the DF card (in thousands of dollars).

DAMAGE REACH CARDS

One set of Damage Reach Cards (DR, DT, SE, LC) is needed for each damage reach indicated, NODR (J3.2).

DR Card: Damage Reach Card (Required Card)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DR	Card identification
1	JDR(I)	+	Damage reach identification code.
2	REFFLD(I)	+	The reference flood water surface elevation (WSE) at the index location.
3	POLELV(I)	+	Used only if IPOL (J1.1) is greater than zero. The water surface elevation (WSE) at the index location indicating the policy level above which all specified development is to be built.
4	PROELV(I)	+	Used only when IPROF (J1.2) = 3 or 4. The water surface elevation (WSE) at the index location which corresponds to the protection level flood event.

DR Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
5	EVCELV(I)	+	Used only if IEVAC (J1.3) is greater than zero. The water surface elevation (WSE) at the index location which corresponds to the evacuation flood event.
6	STRELV(I)	+	The water surface elevation (WSE) at the index location where the aggregated elevation-damage function is to begin (the minimum elevation for computational purposes).
7	ELINTR(I)	+	Increment (in feet) between water surface elevations used in the computation (or aggregation) of damages.
8	IAGGDR(I)	+	Used only when IAG (J1.9) = 1. The value will be the sequence number of the new damage reach created by the aggregation of the damage reach in JDR. (Several JDR, damage reaches, can be combined into a <u>single</u> new damage reach). The specified new values must be in sequence starting with 1.
9	IMODFY	0	No modification to land use category density, structure value, content value and other value as originally input.
		+	The number of land use categories to be modified in the current damage reach, JDR (DR.1).

DT Card: Damage Reach Title Card (Required Card)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	DT	Card identification
1-10	DTITLE(I)	AN	Description of damage reach on preceding DR card, (DR.1).

SE Card: Single Flood Event Card (Optional Card)

The SE card is necessary only for single flood event analysis, ITYPE (J1.8) is positive. Use ITYPE (J1.8) number of values.

SE Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	SE	Card identification
1	SINGLE(1,I)	+	The water surface elevation at the index location of the current damage reach for the first flood event, SEVTIT(1), indicated on the ST card.
2	SINGLE(2,I)	+	The water surface elevation at the index location of the current damage reach for the second flood event, SEVTIT(2), indicated on the ST card.
.	.	.	
.	.	.	
.	.	.	
.	.	.	
10	SINGLE(10,I)	+	The water surface elevation at the index location of the current damage reach for the tenth flood event, SEVTIT(10), indicated on the ST card.

LC Card: Change to Land Use Category Damage Functions (Optional Card)

This card(s) is needed when IMODFY (DR.9) is greater than zero. If this card is used, the complete damage data for the modified land use categories within the current damage reach must be input (fields 1 through 6 must contain coded values). IMODFY number of LC cards should be used.

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	LC	Card identification
1	LUCC	+	Land use category number.
2	DENSTYC	+	Number of damageable units per grid cell.
3	BSEVALC	+	Average dollar value of structure.
4	BSEVLUC	+	Average dollar value of the contents.
		-	The percent of structure value that is used to calculate the value of the contents (30% is recorded as -.30).

LC Card (continued)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
5	BSEINDC	+	Dollar value of other damages.
		-	The percent of total damages that is used to calculate other damages (30% is recorded as -.30).
6	VACNCYC	+	The percent of developed land within the grid cell (80% is recorded as .80).

END Card: Ending Card (Required Card)

<u>Field</u>	<u>Variable</u>	<u>Value</u>	<u>Description</u>
0	CODE	END	Signals end of input data. This card should follow the DATA BANK when NFILE (J2.1) = 5.

*ST	SEVTIT(1)	I = 1, ITYPE								
*FT	(FORMAT)									
*J8	NDR	NLU								
*J7	JEVAC(1)	JEVAC(2)	JEVAC(1)							
*J6	DROP(1)	DROP(2)	DROP(1)							
*J5	JPRF(1)	JPRF(2)	JPRF(1)							
*J4	JPOL(1)	JPOL(2)	JPOL(1)							
J3	IDAMRC	NODR	ILAND	IBASE	NOLUC	ITOPD	IRFED	IELV		
J2	NFILE	NFORM	NDV	IRON	ICOL	IMAGE				
J1	IPOL	IPROF	IEVAC	IEVCLU	IPRNT	ITRACE	IAUTO	ITYPE	IAG	
T3	OUTPUT TITLE INFORMATION									
T2	OUTPUT TITLE INFORMATION									
T1	OUTPUT TITLE INFORMATION									
1	2	3	4	5	6	7	8	9	10	
(Fields)										

* Optional Card

DAMCAL CARD STREAM

